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HANDBOOK ON SANITATION OF VESSEL CONSTRUCTION. STANDARDS OF SANITATION AND RATPROOFING FOR THE CONSTRUCTION OF VESSELS

Public Health Service
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HANDBOOK
ON SANITATION OF

Vessel Construction

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

HANDBOOK ON SANITATION OF

Vessel Construction

STANDARDS OF SANITATION
AND RATPROOFING FOR THE
CONSTRUCTION OF VESSELS

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

I

Public Health Service Publication No. 393

FOREWORD

During a sea voyage, a ship is a person's home. The passenger and seafarer expect to find aboard the vessel all services and facilities necessary for their comfort, health, and welfare.

Present-day travel on modern ships is safe, from a health standpoint. Disease outbreaks due to faulty sanitation or inadequate rodent control rarely occur. This advancement has resulted from the splendid collaboration of naval architects, shipbuilders, operating companies, and the many industries who supplied the equipment and materials. By sponsoring special studies and conducting research on various phases of vessel sanitation, the United States Public Health Service shared in this accomplishment.

In order for a safe and sanitary environment to be achieved, it is necessary that certain facilities be provided, and that health hazards be excluded when the vessel is built. Set forth in this handbook are minimum public-health standards relating to general sanitation and ratproofing in the construction of vessels. These standards have been developed over a period of several decades; experience has shown that their observance during construction, reconstruction, or major repair, will make it much easier to maintain the vessels in an acceptable, sanitary condition during operation.

Prepared by the Division of Sanitary Engineering Services of the Public Health Service, Department of Health, Education, and Welfare, this handbook supersedes the publication, *Principles of Sanitation Applicable to the Construction of New Vessels,* dated June 1, 1949. The standards contained herein are essentially the same as those included in the former publication, but appropriate revisions have been made in recognition of operating experiences and technological advancements. Advice was requested from naval architects, shipbuilders, vessel owners and operators, industrial suppliers, and other Government agencies. Their suggestions and comments have made it possible to produce a more practical handbook than would otherwise have been the case.

This publication is one of two handbooks dealing with vessel sanitation. The other, entitled *Handbook on Sanitation of Vessels in Operation,* PHS Publication No. 68, was issued in 1951.

Improved methods and equipment, undoubtedly, will be developed from time to time. Such developments will lead to changes in existing standards of sanitation for vessel construction. This handbook will be revised accordingly, as circumstances may require.

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Section A. POTABLE-WATER SYSTEM

1. GENERAL. The term *potable water,* as used herein, means water which meets the requirements of the Public Health Service *Drinking Water Standards.*[1]

Whenever practicable, only one water system should be installed, supplying potable water for drinking, cooking, dishwashing, ablutionary, hospital, and laundering purposes. Where dual systems must be installed, potable water should be piped to outlets where it may be used for drinking, cooking, dishwashing, or medical-care purposes (exclusive of hydrotherapy), but it need not be piped to slop sinks, lavatories, laundry facilities, bathtubs, showers, water closets, and bibb connections used for deck-flushing purposes.

It is preferable, from a public-health standpoint, that water for potable-water purposes should be obtained from approved shore supplies. This places the responsibility for water purification upon trained, professional waterworks operators who have laboratory facilities, equipment, supplies, and expert advisory service available when needed. When purification on board is necessary, the method selected for use should be that which is best suited to the water to be treated and most easily understood by the operating officers and seamen.

2. FILLING HOSE. A special hose should be provided for loading potable water from shore sources, except on lake and river vessels which obtain potable water by distillation or other treatment. The hose should be durable, should have a smooth, impervious lining, and should be equipped with the necessary fittings for fastening it to the filling line and the hydrant. It is preferable that the fittings be different from those on other hoses on the vessel, and suitable adapters for connecting them to hydrants should be provided. For vessels whose specific needs are not known, at least two 50-foot sections should be provided.

3. FILLING-HOSE STOWAGE. The potable-water hose, and such hydrant adapters as may be required, should be stowed near the vessel's filling-line connection. They should be stowed in a closed cabinet or on a rack or reel, or should be placed under a deckhead or on the upper part of a bulkhead of an interior passageway. When a cabinet, rack, or reel is used, it should be at least 18 inches above the deck, and should be used for no other purpose. When the hose is stowed on a rack or reel or hung on brackets, means should be provided to secure the hose to its support or to the bulkhead. A hose which is not stowed in a closed cabinet should have

[1] Subpart J of the *Interstate Quarantine Regulations,* as amended March 3, 1951.

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its ends plugged or capped with threaded, metal fittings. The hose cabinet or stowage space should be clearly marked with a sign reading POTABLE-WATER HOSE ONLY.

4. FILLING LINE. Every potable-water tank which is regularly or occasionally filled by hose should have an independent filling line to which a hose can be attached. This line should not be cross-connected with any line of a nonpotable-water system, and should not pass through any nonpotable liquid.

The filling line should begin, either horizontally or in a gooseneck pointing downward, at a point at least 18 inches above the top of the tank or of the deck which the line penetrates. Screw threads, or other devices permitting hose attachment on the end of the potable-water filling line, preferably should be different from the threads or devices on other filling lines and on fire hydrants. The filling line should have a screwcap or plug fastened by a chain to an adjacent bulkhead or surface in such a manner that the cap or plug will not touch the deck when hanging free. Each filling line should be clearly marked, at or near the point of hose connection, with a sign reading POTABLE-WATER FILLING. The filling line within the vessel should be painted or stenciled, as recommended in item 15, page 8.

5. STORAGE CAPACITY. Adequate storage should be provided for potable water. In determining the amount, consideration should be given to the size of the crew, the maximum number of passengers to be accommodated, the frequency with which water can be loaded from approved sources, the availability of water suitable for treatment and facilities for treating it, and the types of water systems aboard.

The consumption values given in table I, below, are intended merely as guides for the amount of storage required. The actual unit values will depend upon the type of vessel and the service in which it is engaged.

The amount of storage may be decreased when the potable-water supply will be supplemented with water purified aboard, but only by such an amount as can be supplied dependably by the purification process.

TABLE I.—*Approximate minimum rates of consumption of domestic water on vessels*

Item	Gallons per person per day		
	Drinking-cooking system	Wash-water system	Combined system
Drinking water:			
Crew, passengers	0.7	.....	0.7
Cooking water:			
Cooking, vegetable and fruit washing	0.8	.....	0.8
Dishwashing	5.0	.....	5.0
Washing:			
Baths	.....	16.0	16.0
Lavatory	.....	5.0	5.0
Laundry	.....	1.0	1.0
Cleaning in galley, pantry, and dining room	1.5	.....	1.5
Total	8.0	22.0	30.0

When the entire potable-water supply is obtained by distillation of overboard water, or by chlorination of overboard fresh water, sufficient storage should be provided to preclude the need for treating overboard water from harbors or other heavily contaminated areas, and to allow time for maintenance and repair. The treatment of water from heavily contaminated areas can be avoided by loading from approved shore sources while in port, or by the treatment of water from wash-water tanks which have been filled from satisfactory sources. In the latter case, total storage requirements can be made up of a combination of wash-water storage and potable-water storage, but in no case should the potable-water storage be less than a 2-day supply.

6. STORAGE TANKS. Potable water should be stored in one or more tanks which are so constructed, located, and protected as to be safe against any contamination from the outside. Such a tank should be constructed of metal or other suitable material. It should be independent, with no common partition with a tank holding nonpotable water or other liquids, except as outlined in the next paragraph. The tank should be independent of the shell of the ship, unless the bottom of the tank is at least 2 feet above the maximum-load waterline, and all shell seams and connections, including frames, in way of the tank are continuously welded on the inside of the tank. There should be no rivets in that part of the shell or shell connections which form the side of the tank.

A common partition with a distilled-water tank is acceptable, provided that the distilled-water tank is supplied with distilled water of at least the same quality being supplied to the potable-water tank, and that any filling line to the tank meets the requirements outlined in item 4, page 2. In addition, the discharge of water from the distilled-water tank to the boiler-feed system or to a nonpotable-water system should be through an airgap. (See fig. 4, p. 13.)

A deck may be used as the top of a potable-water tank, provided that there are no access or inspection openings therein, and that the seams are continuously welded on the inside of the tank. There should be no rivets in that part of the deck which forms the top of the tank. No toilet or urinal should be installed over that part of a deck which forms the top of a potable-water tank. A deck may form the bottom of a potable-water tank, provided that it does not also form the top of a tank which holds nonpotable water or other liquids.

The bottom of any potable-water tank which is located in the lower part of the ship should be at least 18 inches above the top of inner-bottom tanks used for the storage of liquids. (See fig. 1A, p. 4.) When an operating deck, platform, or grating is installed in the vicinity of the potable-water tank and near the inner-bottom plating, it is preferable that the bottom of the potable-water tank be above such operating deck, platform, or grating. (See fig. 1B, p. 4.) In the absence of inner-bottom plating, the bottom of the potable-water tank should be at least 18 inches above the lowest point

of the bilge space (not a sump or drainwell—see fig. 1C, below). The bottom of a potable-water tank may be formed by the inner-bottom plating, as shown in fig. 1D, provided that:

a. An 18-inch-deep void space exists underneath; and

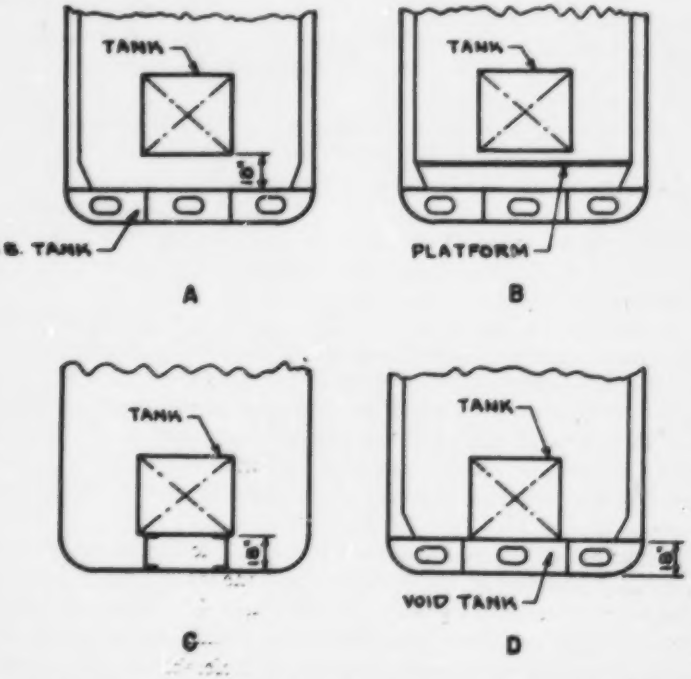
b. There is no way for the void to be filled; and

c. The void space and the inner-bottom plating around the tank are provided with means for adequate drainage.

If the material of which a tank is constructed should require coating, such coating should not render the water stored therein unfit for human consumption.

No drainline or pipe carrying nonpotable liquids should pass through the tank unless a tunnel of acceptable construction is provided. Tunnels should be made of heavy plate and should be placed on a continuous slope for drainage purposes; and the pipe therein should be of extra-heavy steel with butt-welded joints. Lines carrying sewage or other highly contaminated liquids should not pass directly over the manhole in the tank.

The potable-water tank should be conspicuously labeled POTABLE WATER.



ACCEPTABLE LOCATION OF POTABLE WATER TANKS IN RELATION TO BILGE OR INNER BOTTOM TANK

Figure 1.

Vessels using tanks which do not meet the above recommendations should have provision for suitable treatment of water drawn from those tanks before its use as potable water.

7. STORAGE-TANK VENTS. Potable-water storage-tank vents should be of adequate size, and so located and constructed as to prevent the entrance of contaminating substances. If exposed to the weather, they should be screened with 16-mesh or finer corrosion-resistant wire. A vent should not be connected to the vent of any tank holding nonpotable liquid.

A single pipe without takeoffs may be used as a combined vent and overflow. The vent, or combined vent and overflow, should terminate with the open end pointing downward. It may terminate at the side of the tank near the bottom of the ship (as specified in sec. F, item 6, p. 25), at least 18 inches above the top of the potable-water tank or above a weather deck in a sheltered space. When the end must be exposed to wave action, it should be equipped with a backwater (check) valve.

8. STORAGE-TANK OVERFLOWS. It is preferable that the potable-water tank be provided with an overflow, which should be so located that the design capacity of the tank is maintained, and whose diameter should be equal to, or greater than, the diameter of the filling line. The overflow should be constructed and protected in the same manner as recommended for vents in item 7, above.

An overflow may be combined with a vent, but the provisions described for the construction and protection of both vents and overflows should be observed.

9. STORAGE-TANK MANHOLES. It is preferable that the potable-water tank be provided with a manhole, to provide access into the tank for cleaning purposes. The manhole should be located in the side, but may be in the top when the top is not formed by a deck. When located in the top, it should be provided with a coaming, or curb, raised at least one-half inch above the tank-top. The cover should extend to the outer edge of the curb or flange, and should be provided with a gasket and a device for securing it in place. Flush manholes will be acceptable in the sides of tanks.

10. WATER-LEVEL GAUGES. Any means provided for determining the depth of water in the potable-water tanks should be so constructed as to prevent the entrance of contaminated substances or liquids into the tanks.

Devices which are considered satisfactory for determining the water level in a potable-water tank include:

a. Water-gauge glass with shutoff valve on a side of the tank.

b. Petcocks at appropriate intervals on the side of the tank.

c. Petcocks installed in a vertical, offset pipe which is connected to the tank near the bottom.

d. Water-level indicators actuated by air pressure. (The air may be supplied by a handpump, or an independent compressor, or through a

"press-on" valve with a filter or liquid trap installed in the supply line from the main compressed-air system.)

e. An enclosed float gauge.

f. A water-operated pressure gauge.

11. TANK DRAINS. The potable-water tank should be so designed that it can be completely drained. The drain opening should be of at least one and one-half-inch diameter. When drainage is by gravity flow, the opening should be in the bottom of the tank and should terminate flush with, or below, the inner surface of the tank bottom. The installation should be such as to avoid a reinforcing plate, a raised welding bead, or a protruding pipe in way of the hole, which would prevent complete drainage. This can be accomplished as shown in figure 2 (A and B), page 7. When the potable-water-pump suction line is used to drain the tank, it should drain from a sump, as shown in figure 2C. In addition, the drain in the discharge line should be located ahead of any branch takeoff to the distribution system. A valve should be installed on the main immediately beyond the drainline takeoff.

A screwplug or capped nipple should be installed on a tank drain only where it is easily accessible and where the water can be wasted directly therefrom. When a pipe drainage system is installed, it should be independent of all other drainage systems, and should be protected as specified in section F, item 6, page 25. The drainline should be plugged or capped, to prevent the loss of water in case the drain valve should become loosened by vibration, unless a locking-type valve is provided.

12. DISTRIBUTION SYSTEM. The distribution lines, including the suction lines of the potable-water pump, should not be cross-connected with the piping or storage tank of any nonpotable-water system. There should be no blind or spectacle flanges, nor any removable or swing sections of pipe in the lines, whereby such a connection can be made.

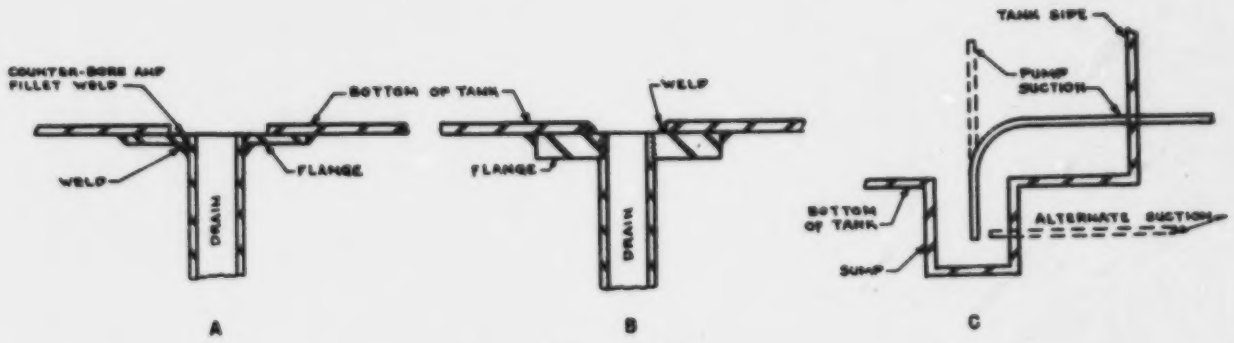
The distribution lines should be located so they will not be submerged in bilge water, nor pass through tanks storing nonpotable liquids.

The distribution system should be protected against the introduction of contamination by backflow, as specified in section F, item 6, page 25.

No direct connection from the potable-water system should be made for the purpose of cooling machinery or operating an aspirator, ejector, or other hydraulically operated device. A hot-water heating, air-cooling, or air-conditioning circulating-water system should not be supplied directly from a potable-water system, unless it is a closed system with no nonpotable water connections, and unless the water is not used for heat-exchange purposes in a unit containing toxic materials.

Cold, potable water should not be used for cooling boiler water for testing purposes, unless it is either supplied to or discharged from the cooler through an airgap.

Potable-water outlets should be provided in or near passenger, officer, and crew quarters, and in the engine and boiler rooms. Drinking-water



TANK DRAINS

Figure 2.

fountains (see section F, item 7, page 26) should be installed, if practicable.

Coolers which permit direct contact of ice with the water, or which consist of a cooling chamber into which a water-filled bottle is inserted in an inverted position, should not be used for dispensing drinking water.

Hot and cold potable water should be piped to the galley, pantry, and scullery. Steam which is to be applied directly to food should be made from potable water. Boiler steam is satisfactory as a means of heating potable water and food if applied indirectly, as through coils, tubes, or separate chambers.

Hot and cold potable water should be piped to the hospital and other medical-care spaces for handwashing and medical-care purposes (but not necessarily for hydrotherapy, toilet and bedpan flushing, or bathing).

Only potable water should be piped to the freezer for making ice for drinking purposes.

13. PUMPS. The potable-water pump should have adequate capacity for service demands, and should be used for no purpose other than for pumping potable water. The installation of a standby pump is recommended for emergencies, such as a breakdown in the main unit serving the potable-water system.

Handpumps, which are to be installed on some vessels to serve galleys and pantries for emergency or routine use as a supplement to pressure outlets, should be so constructed and installed as to prevent the entrance of contamination into the potable-water storage tank or into the water being pumped. No pump-heads with slotted tops, nor pitcher-type pumps, should be installed.

14. PNEUMATIC (PRESSURE) TANK. Compressed air which is to be introduced into a pneumatic tank should be supplied by:

a. A "snifter" (air-intake) airvalve on the potable-water pump, or

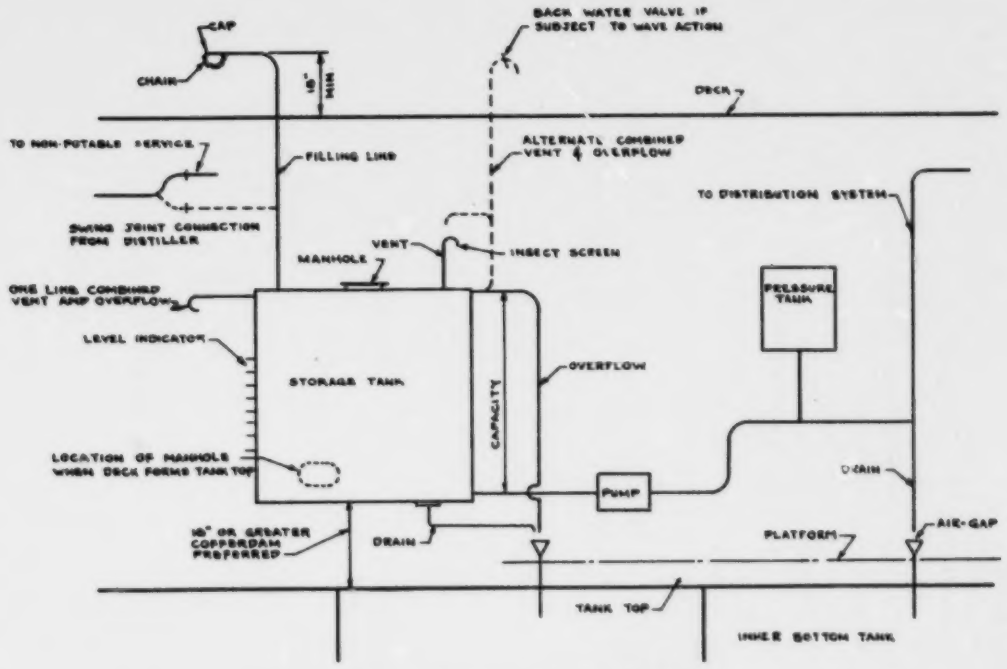
b. An independent compressor, or

c. A main compressed-air system using a press-on valve with a filter or liquid trap installed in the supply line (the liquid trap being installed in the line leading directly to the pressure tank, and not less than 2 inches in diameter and 8 inches in length), or

d. Any other device which will prevent contamination of the potable water.

15. IDENTIFICATION AND MARKING. The piping of the potable-water system, including the filling line, should be suitably stenciled, painted light blue, or striped with 6-inch light blue bands, at fittings, on each side of partitions, decks, and bulkheads, and at intervals not to exceed 15 feet in all spaces except quarters, dining rooms, salons, and similar public places where the decor would be marred by such marking.

When potable water is produced aboard the vessel by treatment, the identifying markings of the piping system should begin at a point beyond the last treatment unit. For example, when distillation is the treatment



TYPICAL INDEPENDENT WATER SYSTEM

Figure 3.

process, the piping should be marked from the swing connection or the air-gap, and on through the potable-water storage tank and distribution system. When superchlorination and dechlorination are involved in the treatment process, the markings should begin immediately following chlorination. When chlorination alone is used, the piping beyond the retention tank should be marked.

The bodies of valves installed in that part of the potable-water system which is marked should be appropriately labeled.

All nonpotable water outlets should be labeled UNFIT FOR DRINKING. In some cases, faucets for both potable and nonpotable water may be so located as to be indistinguishable from each other. To avoid confusion in such cases, it is advisable to label the potable-water outlet POTABLE.

16. DISINFECTION. Before being put into service, the potable-water storage tank and distribution system should be cleaned, disinfected, and flushed. Where a water distiller is connected to the potable-water tank or system, the pipe and appurtenances between the distiller and the potable-water tank or system should be disinfected by the same treatment as that given the potable-water system.

17. PROCEDURE FOR DISINFECTION. Chlorine compounds which are used for disinfecting water systems are chlorinated lime, high-test hypochlorite, or commercially prepared liquid sodium hypochlorite. Chlorinated lime and liquid sodium hypochlorite can be purchased at almost any grocery or drug store. As these compounds deteriorate on exposure to air, they should be purchased in small containers, which should be tightly closed after use. All such products should be kept in a cool, dark place. The following instructions should be utilized in the disinfection of potable-water systems by the use of chlorine compounds:

a. Thoroughly scrub the storage tanks, and flush the tanks and distribution system with potable water.

b. Determine the volume of water necessary to fill the tanks and distribution system completely. The amount of disinfecting agent required may be determined from table II, page 11.

When chlorine compounds or solutions other than those noted in the table are used, the dosage should be:

$$\text{Dosage of powder} = \frac{70}{\text{percent chlorine in compound}} \times \text{dosage in 70-percent column.}$$

$$\text{Dosage of liquid} = \frac{5}{\text{percent chlorine in liquid}} \times \text{dosage in 5-percent column.}$$

c. Prepare the chlorine solution as follows:

(1) *Chlorinated lime.* Place the proper amount of chlorine compound in a clean, dry bucket. Add a small amount of water, and mix to a thick paste. Dilute the paste by adding water gradually and stirring constantly, until a gallon or two of solution is obtained. (Warm water is better than cold for this purpose.) Allow the solution to stand for 30 minutes, so that

the undissolved particles may settle to the bottom. Pour off the clear liquid (which is the chlorine solution) and, if necessary, filter it through muslin or cheesecloth.

TABLE II.—*Amount of chlorine compound required for a 50-p. p. m.[1] solution*

Capacity of system (including tanks)		Amount of chlorine compound			
		Chlorinated lime (25 percent)	High-test calcium hypochlorite (70 percent)	Liquid sodium hypochlorite	
Gallons	Tons			5-percent solution	10-percent solution
		Pounds	*Pounds*	*Gallons*	*Gallons*
1,000	4	1.6	0.6	1	0.5
2,000	8	3.2	1.2	2	1.0
5,000	21	8.0	3.0	5	2.5
10,000	42	16.0	6.0	10	5.0

[1] Parts per million.

NOTE: A heaping tablespoon holds approximately ½ ounce; a measuring cup, approximately 6 ounces.

(2) *High-test hypochlorite.* Place the proper amount in a bucket, fill with water to within a few inches of the top, and stir until the powder is dissolved. (Disregard slight turbidity, if any.)

(3) *Liquid sodium hypochlorite.* These solutions require no preparation.

d. Introduce the chlorine solution into the potable-water tanks.

e. Immediately after introducing the chlorine solution, the tanks should be completely filled with potable water. Sufficient mixing usually will be obtained by the swirling action of the incoming water.

f. Open the taps and outlets on the distribution system nearest the storage tanks, and allow the water to flow until chlorinated water appears. After the nearest taps have been opened, the process should be continued outward from the tanks until all taps and outlets have been flushed with chlorinated water. Care should be taken to insure that the pressure tank is filled with chlorinated water. Since a certain amount of the chlorinated water will have been drawn from the storage tanks, they should be refilled to overflowing, and chlorine solution should be added, if necessary, to obtain the 50-p. p. m. dose in the tanks.

g. After the storage tanks and the piping system have been filled, the chlorinated water should be allowed to stand in them for at least 4 hours before discharging the water. In an emergency, the contact time may be shortened to 1 hour by increasing the dosage to 100 p. p. m.

h. After this contact period, the tanks and distribution system should be drained and then flushed with potable water until the chlorine taste is not objectionable.

i. Fill the storage tanks with potable water.

18. PURIFICATION OF WATER. Water which is to be purified on board for use as potable water may be stored in tanks formed by the shell of the vessel, provided that such tanks are free from apparent leakage, have

no drains passing through them, and are adequately protected against both the backflow and the discharge thereto of bilge or highly contaminated water.

Treatment facilities, where provided, should be suitable for the water to be purified, and should be designed to ensure efficient operation and the production of a potable water which conforms to the *Public Health Service Drinking Water Standards.* Overboard water which is to be treated on vessels should be taken from areas relatively free from contamination and pollution. Bypasses should not be installed around treatment units, except where necessary as part of the treatment process. A sufficient supply of vital and fragile parts of the treatment apparatus should be available.

River water should be distilled before use as potable water.

Water drawn from areas in the Great Lakes which are relatively free from contamination, if properly chlorinated, will be acceptable as potable water.

The water-storage capacity in connection with a purification system should be as recommended in item 5, page 2.

When overboard water is treated on board, the discharge of sewage (in relation to the water intake) should be as specified in section F, item 8, page 26.

a. *Chlorination.* When water is to be regularly disinfected with chlorine, the chlorine should be applied in the form of a hypochlorite solution, using a commercial hypochlorinator which has been designed to produce the desired results. It is desirable to apply the chlorine in direct proportion to the instantaneous flow-rate of the water being treated. Therefore, an automatic, proportional-control hypochlorinator should be used. It should be constructed or equipped so that the flow of the hypochlorite solution may be observed. Its capacity should be determined on the basis of the maximum rate of flow of water and the treatment required to produce a satisfactory chlorine residual (not less than 0.2 p. p. m. of free chlorine or 1.0 p. p. m. of chloramine). A sampling cock should be provided at an appropriate place in the system for taking test samples to check the chlorine residual and the operating efficiency of the feeder. A commercial testing kit for determining the chlorine residual should be obtained with the hypochlorinator.

When water is treated regularly by chlorination, provision should be made for a baffled holding tank of sufficient capacity to provide a suitable contact period for the chlorine and water. This period of contact should be provided before any water is delivered to the next successive treatment unit or to the distribution system, and should be computed on the basis of maximum rate of flow through the contact tank. When a normal dosage of chlorine is applied, the contact period should be at least 20 minutes, with a resultant residual of 0.2 p. p. m. When superchlorination is practiced, a shorter period of contact may be satisfactory.

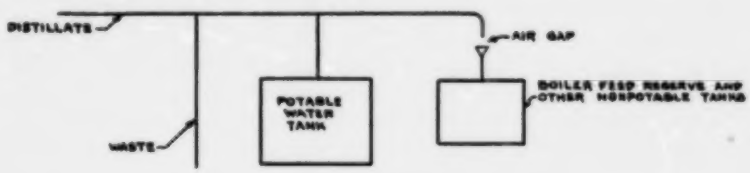
b. *Filtration.* Filtration should be practiced only when it is a necessary part of a purification process which includes a bactericidal treatment.

Filtration of potable water, through charcoal, activated carbon, or other types of filters, is considered unnecessary except for dechlorinating purposes. When such a unit is installed, a means should be provided for the satisfactory disinfection of the filtering medium after it has been placed in the filter, and for periodic disinfection thereafter, unless the unit is of the type which utilizes replaceable cartridges.

c. *Distillation.* A distilling plant which supplies water to the potable-water system should be of such design that it will produce potable water regularly.

Provision should be made in the evaporator to prevent flooding and to minimize foaming or carry-over of water into the distiller condenser. The steam coil or tubes in the evaporating chamber, and the cooling coils in the distiller condenser and the condensate cooler, should be arranged to facilitate inspection for corrosion, pitting, or leaks.

For a plant which will produce water for both nonpotable and potable systems, provision should be made to avoid cross connections. This should be accomplished by the use of an airgap, as shown in figure 4, or a swing connection (reversible ell), as shown in figure 5, or any other approved device. The airgap arrangement is preferred.



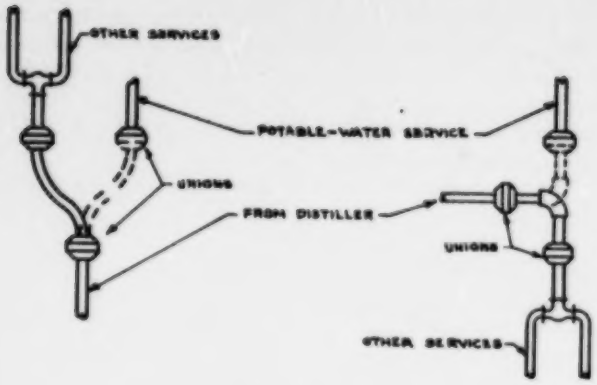
AIR GAP PROTECTION OF DIRECT DISTILLATE DELIVERY TO POTABLE-WATER TANK

Figure 4.

When airgaps are provided in the discharge lines to all nonpotable systems, a direct connection may be made to the potable-water system.

Any swing connection which is used should be so arranged that the discharge from the distilling plant is connected to the potable-water system only when water is being discharged to that system. It should be placed in the primary discharge line at any point beyond the condensate pump, or beyond the test tank when delivery to the point of usage is by gravity flow, and it should be located preferably in the space occupied by the distillation plant. It should be equipped with easily operated fittings, and should be readily accessible for changing from one position to the other. The receiving end of the potable-water connection should be in a horizontal position, or in a vertical position pointing downward. A plug should be provided for the receiving end of the potable-water line.

A copy of the manufacturer's operating instructions should be posted near the distillation plant.



SWING CONNECTIONS
Figure 5.

(1) *High-pressure units.* Atmospheric-pressure distilling plants, and those operating above atmospheric pressure, should be provided with a means to waste the distillate when the discharge line is connected to the potable-water system, in case the distillate should be unfit for use.

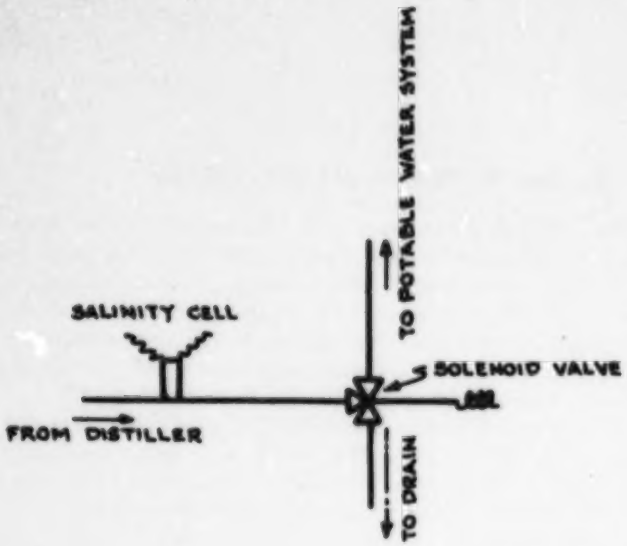
(2) *Low-pressure units.* Low-pressure or partial-vacuum distillation plants, which operate with pressures lower than atmospheric in the boiling chambers, should be so designed that they will consistently produce water containing not more than one-fourth grain (4.3 p. p. m.) of salinity per gallon, from sea water. A plant of this type should be equipped with a low-range, electrical salinity indicator for determining the salinity of the distillate at a point beyond the final condensate cooler. A flow-diversion valve should be provided to divert the flow of water from the potable-water tanks when the salinity of the distillate exceeds one-fourth grain per gallon. (See figure 6, below.) This valve should operate instantaneously, and should be controlled by a salinity cell. The electrical control for this valve should be so arranged that the valve will operate regardless of the position of the selector switch on the salinity-indicator panel, and the flow of water should be diverted from the potable-water tank when the current is off. In addition, an alarm should be provided to warn the operator when the salinity of the condensate exceeds one-fourth-grain per gallon.

When evidence is lacking of the dependability of a low-pressure plant to produce water of one-fourth-grain salinity under operating conditions, or when fresh- or brackish-water feed is used, one of the following measures should be taken:

(a) Maintain a temperature of 165° F. or higher in the boiling chamber, or

(b) Provide for heating the distillate to 165° F. or higher, or

(c) Provide facilities for adequate chlorination of the distillate.



SALINITY CELL - SOLENOID VALVE ARRANGEMENT

Figure 6.

Section B. WASH-WATER SYSTEM

1. GENERAL. A single water system, supplying potable water for drinking, cooking, dishwashing, ablutionary, hospital, and laundering purposes, should be installed when practicable. However, when a wash-water system is installed in addition to a potable-water system, wash water may be piped to slop sinks, lavatories, laundry facilities, bathtubs, showers, water closets, bibb connections used for deck-flushing purposes, and other special uses, as indicated in item 3, below.

Great Lakes water which is taken from areas unaffected by contaminated drainage, either from the shores or from vessels, is generally satisfactory to use as wash water without prior treatment. When water for washing purposes is to be taken from rivers, equipment should be installed to provide filtration and chlorination prior to use.

2. STORAGE TANKS. Wash-water-storage tanks should be so constructed as to minimize the possibility of the water therein becoming contaminated. Double-bottom, fore and aft peak, wing, and topside tanks, and tanks with sides common to other nonpotable-water tanks, are satisfactory, provided that no drainlines pass through them, that they have covered manholes, and that all sounding tubes are capped or plugged. When a deck forms the top of a wash-water tank, all openings should be curbed and covered. The tank should be adequately protected against the backflow or discharge thereto of bilge or highly contaminated water.

3. DISTRIBUTION SYSTEM. The distribution lines, including the suction lines of a wash-water pump, should not be connected directly to any system or manifolds which may handle bilge, fire, or other contaminated water, except where necessary to effect a quick transfer of water from one tank to another. In this case, a connection will be permitted to the ballast system, provided that the suction or discharge lines to the ballast pumps are independent of the suction and discharge piping of the wash-water system.

The suction line to a wash-water pump should be so located as to prevent its submergence in bilge water.

Wash-water lines to fixtures handling sewage wastes should be protected against backflow, as specified in section F, item 6, page 25.

Wash water may be piped into the hospital or other medical-treatment space for use in hydrotherapy, and for any other purpose except handwashing, medical care, and drinking.

Wash water may be piped to a garbage-grinder, provided that the delivery line is protected against backflow. Wash water should not be piped into

the galley, pantry, or scullery, except for deck-flushing purposes, and then only if the outlet is not more than 18 inches above the deck. These outlets should be clearly posted with signs reading FOR DECK-WASHING ONLY.

4. **SALT-WATER BATHS.** Salt-water service to bathtubs and showers should be independent, with no cross connections to either the potable-water or wash-water system. The supply line should originate at a point in the salt-water system where adequate flushing will occur between the time the vessel leaves polluted water and the time water will be drawn for bathing purposes. Adequate flushing can best be assured by having the supply line originate at or near the pump. A shutoff valve should be installed, so that this service can be made inoperative while the vessel is in polluted water. This shutoff valve should be installed just beyond the point of takeoff from the vessel's main salt-water system, and should be labeled KEEP CLOSED WHILE IN HARBORS. The principle is the same as shown for swimming pools in figure 14, page 31.

Section C. SANITARY- OR OVERBOARD-WATER SYSTEM

1. GENERAL. The sanitary- or overboard-water system should be independent of the potable-water and the wash-water systems. All faucets on the sanitary- or overboard-water-distribution system should be clearly labeled with signs reading UNFIT FOR DRINKING.

Overboard water should not be piped into the galley or pantry for deck-flushing purposes, unless the supplies of potable water and wash-water are limited. Overboard water outlets in the food spaces should be not more than 18 inches above the deck, and should be labeled FOR DECK-WASHING ONLY. DO NOT USE IN HARBORS.

Water from the sanitary system may be piped to a garbage-grinder. When a connection to the unit is such that it is possible for this water to be used for other purposes, the pipeline within the galley should be distinctly labeled, or painted orange. There should be no outlets from the sanitary-water system in the hospital or other medical-treatment spaces, except those for flushing waste-disposal units, such as toilets, bedpan washers, and slop sinks.

Section D. VESSEL-TO-SHORE PRESSURE-WATER CONNECTION

1. GENERAL. When facilities installed on a vessel make it possible to connect any nonpotable-water system on the vessel to a potable-water system on a pier for the purpose of utilizing the pressure from the pier system, a standard device, such as a check valve, should be installed on the vessel, at or near the inlet of the nonpotable system, to prevent flow of water from the vessel to the shore.

Section E. SPACES FOR THE STORAGE, PREPARATION, AND SERVICE OF FOOD

1. DECKS. The decks or flooring of all spaces in which food or drink is stored, prepared, or served, or in which utensils are cleaned, should be so constructed as to be easily cleaned. The bottoms of shaft wells in these spaces should be so constructed as to facilitate cleaning and inspection.

2. BULKHEADS AND DECKHEADS. Bulkheads and deckheads of spaces in which food is stored or prepared, or in which utensils are cleaned, should have hard-finished, smooth, light-colored, washable surfaces.

Fibrous insulation or like material should be sheathed in such a manner as to prevent particles of the insulation from falling upon food. The use of just cloth or plaster surfacing is not satisfactory.

Fibrous air filters should not be installed in the deckhead or over food-processing equipment.

Perforated, acoustical material should not be installed in galleys, pantries, sculleries, or other food-preparation or -storage spaces. It will be acceptable in dining spaces, provided that the sound-absorbing material is of such a nature, or is so sheathed, as to prevent particles from falling through the holes and seams. (See sec. J, item 29, p. 50.)

3. PIPING IN DECKHEADS. Pipes in unsheathed deckheads over spaces where food is stored or prepared, or where utensils are washed, or over portions of spaces from which food is regularly dispensed, should be insulated if condensation is likely to form on them.

The passage of drainage lines in the deckheads of food spaces should be avoided where possible. Where unavoidable, they should be constructed as specified in section F, item 8, page 26.

4. DRAINAGE OF SPACES. Butcher shops, galleys, sculleries, and other food-preparation spaces should be provided with one or more drains, and the flooring should be sloped thereto. Drainage gutters may be used, provided that they are so located as to be easily accessible for cleaning. If cover plates are installed over the gutterway, they should be easily removable, and should be made of heavy, flat, expanded metal or perforated plate.

Drains from refrigerated spaces should be protected against backflow, as indicated in section F, item 11, page 27.

5. INSECT SCREENS. An effective means should be provided for the exclusion of flies from spaces in which food is stored, prepared, or served, while the vessel is in port during the seasons of the year when flies are prevalent. All openings from food spaces to the outer air should be effectively

screened with not less than 16-mesh wire or plastic cloth. Door screens should be self-closing and, whenever practicable, should be outward. Skylights which are located above food spaces, and which can be opened, should be equipped with insect screens which are easily removable for cleaning. Window and door screens should be tight-fitting.

Forced-draft-ventilation openings into food spaces do not require insect screening. Tight-fitting, self-closing louvers are satisfactory, and are preferable to mesh cloth in the outlets of forced-draft-exhaust openings.

6. TOILET AND LAVATORY FACILITIES. Adequate toilet facilities should be located convenient to food-preparation spaces. Toilet-room doors opening directly into food-preparation or -serving areas should be self-closing and tight-fitting.

Hand-washing facilities (including hot and cold, running, potable water) and means of dispensing soap and individual towels should be provided in or convenient to toilets; preferably, they should be installed in each galley and pantry, or combinations thereof. On smaller vessels, it may not be necessary to furnish dispensers for single-use towels if each food-service employee is provided with an individual towel for his own use. A warm-air jet, in lieu of towels, will be considered satisfactory. A sign reading WASH HANDS AFTER USING TOILET should be placed where it will be readily observable by food-service personnel. Slop sinks and scullery sinks or vats are not satisfactory as handwashing facilities.

7. WATER SUPPLY. Only potable water should be piped into spaces where food is stored, prepared, or served, except as indicated in section B, item 3, page 16. The potable-water system should be protected against backflow, as recommended in section F, item 6, page 25.

8. LIGHTING. All working surfaces in spaces where food or drink is prepared, or where utensils are cleaned, should be provided with illumination of not less than 10 foot-candles. (This standard of lighting does not apply to the dining room.) Storage rooms should be lighted sufficiently to promote cleanliness and to facilitate sanitary operations.

9. VENTILATION. All spaces in which food is prepared or stored should be ventilated sufficiently to be reasonably free of disagreeable odors and condensation. Natural ventilation should be supplemented by mechanical ventilating systems, as needed.

10. DISPOSAL OF REFUSE. Means should be provided for the storage and disposal of refuse.

11. EQUIPMENT. Utensils and equipment should be so designed and fabricated as to be free of sanitary defects which present a health hazard. Surfaces which come into contact with food and drink should be constructed of materials which are impervious, corrosion-resistant, nontoxic, smooth, easily cleanable, durable, free-draining, and resistant to chipping.

To facilitate cleaning, the minimum clearance between the deck and the undersurface of equipment should be at least 6 inches, unless the base is cemented to the deck so as to make a verminproof bond. The front

surface of the equipment may be recessed to provide toe space. It is suggested, where practicable, that bottom shelves of open-base fixtures be removable, to facilitate inspection, cleaning, and maintenance.

12. WASHING AND BACTERICIDAL-TREATMENT FACILITIES. Facilities should be provided for the washing and bactericidal treatment of eating, drinking, and food-service utensils.[1]

MANUAL METHODS. Water with a temperature of 110° to 120° F. is most suitable for washing utensils by hand. After utensils have been washed, they should be subjected to bactericidal treatment by one of the following methods:

a. By immersion of the utensil or equipment for at least 2 minutes in clean water at a temperature of at least 170° F., or for one-half minute in boiling water. For this procedure, there should be at least a two-vat sink. A rinsing may be performed between washing and bactericidal treatment, if desired.

The vat for bactericidal treatment should be large enough and deep enough for complete immersion of the largest utensil to be sanitized therein. The water in the bactericidal-treatment vat should be maintained at a temperature of 170° F. or more while utensils are being treated. To overcome the loss of heat from the water, it is essential that a heating device (booster heater) be installed which will be integral with the bactericidal-treatment vat, and which, preferably, should be thermostatically controlled. This may be accomplished by the use of one of the following devices:

(1) A steam or electrically heated jacket under or around the vat.

(2) Steam coils within the vat, provided that the unit is removable or rotative to a vertical position for routine cleaning.

(3) A removable, immersion-type, electrical unit in the vat.

(4) One or more steam injectors at the bottom of the vat, installed in such a manner as to effect thorough mixing of the steam and the water. Boiler steam is satisfactory for use in this connection.

(5) A steam or electric recirculation unit attached directly to the bactericidal-treatment vat.

A thermometer should be provided, to indicate the temperature of the water in the bactericidal-treatment vat. The thermometer should be of the dial type, with the dial attached to the splash plate of the sink or to the adjoining bulkhead. If necessary for cleaning purposes, the thermal-immersion unit should be removable from the sink.

Long-handled, wire baskets should be provided for each sink, for the rinsing and bactericidal treatment of eating and drinking utensils.

b. By immersion of the utensils or equipment in a chlorine solution. With this method of bactericidal treatment, three vats should be provided—one vat for washing, the second for rinsing, and the third for chlorine-

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[1] As hereinafter used, the term *utensil* includes any kitchenware, tableware, glassware, cutlery, containers, or other equipment with which food or drink comes into contact during storage, preparation, or serving.

solution immersion. The minimum sizes for bactericidal-treatment vats should conform to the requirements in a, above.

c. Any other method which, upon application, has been determined to be effective in the prevention of the spread of communicable disease.

d. Equipment so designed or installed as to make immersion impractical may be given bactericidal treatment:

(1) With live steam from a hose, if the steam can be confined; or

(2) With boiling rinse water; or

(3) By spraying or swabbing with chlorine solution.

DISHWASHING MACHINES. Dishwashing machines, if used, should be so designed, installed, operated, and maintained that the utensils are rendered free of visible soil, wash water, and detergent, leaving them clean, reasonably dry, and free of microorganisms which present a potential health hazard.

Scrapping facilities should be provided for removing food particles from utensils. Prerinsing facilities are desirable; these, if provided, should maintain the wash water in a cleaner condition, thereby enhancing the effectiveness of the dishwashing machine.

The effectiveness of a spray-type dishwashing machine is contingent upon several factors. Some of these are inherent in its design and fabrication, while others depend upon the provision of satisfactory appurtenant equipment and proper operation and maintenance. Among the factors to be considered are the temperature and volume of the applied wash and rinse waters, the type and concentration of detergent used, the cleanliness and maintenance of the machine (which, in turn, are related to its durability and ease of cleaning), the duration of wash and rinse periods, the spray pattern, and the nozzle sizes and operating pressures.

In view of the above, the dishwashing machine should be designed and fabricated of durable materials which will withstand corrosion and be easily cleanable. Also, it should have inherent design features (such as duration of wash and rinse sprays, spray pattern, quantity, pressures, and control devices) which will assure a satisfactory dishwashing operation under proper installation, operation, and maintenance. This requires:

a. Provision for maintaining the wash water in the machine in the temperature range of 140° to 160° F. The detergent concentration should be maintained, preferably, by an automatic dispenser, or, alternately, by a definite system of manual feeding, such as spreading a level tablespoonful of detergent over each rack of utensils.

b. Provision of an adequate water supply for the dishwashing operation, with a dependable pressure-regulating device (flow-control or pressure-reducing valve) if required, to maintain 15 to 30 pounds of flow pressure on the final-rinse line at the machine, and not less than 10 pounds per square inch at the rinse nozzles.

c. Provision of adequate water-heating facilities, with dependable thermostatic control, to maintain a temperature of 180° F. or more in the final

fresh-water-rinse line at the entrance of the rinse manifold on the machine.

d. Provision of an easily readable thermometer on the final and recirculated rinse-water lines near the entrance to the spray arm or manifold. The installation of suitable indicating thermometers on all tanks of dishwashing machines is desirable, to facilitate correct operation.

e. Provision of sufficient racks and clean-utensil-storage area to permit air-drying (usually about 45 seconds) before removal of utensils from racks following washing.

Note: More detailed specifications for the various types of dishwashing machines may be found in Standard No. 3, *Spray-Type Dishwashing Machines*, adopted by the Joint Committee on Food Equipment Standards and published by the National Sanitation Foundation, Ann Arbor, Mich. (May 1953). Equipment manufactured in conformity with Standard No. 3 will be considered as complying with the sanitary design and construction standards of this manual.

Facilities for the bactericidal treatment of eating and drinking utensils will not be required in the captain's or master's pantry, since this space can be considered as being used by an individual, rather than by a group.

13. STOWAGE OF EQUIPMENT. Provision should be made for the stowage of all utensils in a clean, dry place above the deck, for protection against contamination.

Sufficient stowage space should be provided near the steward's department for the cleaning gear used in food-preparation spaces.

14. REFRIGERATION. Provision should be made for the storage of all readily perishable food or drink at a temperature below 50° F. When such foods are to be stored for extended periods of time, a temperature of 40° F. or less is recommended. Thermometers should be provided in refrigerators, except that a thermometer is not required in a small, commercial refrigerator intended for personal use, such as that installed in the captain's pantry.

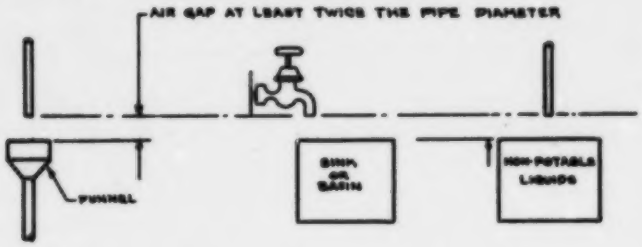
Sufficient shelving should be installed in refrigerators within ship's stores; perishable foods should not be stored on the decks.

15. DEFROSTING OF REFRIGERATOR COILS. If salt water from contaminated harbors or other areas is to be used to defrost exposed coils within the refrigerated space, provisions should be made to heat the salt water to 165° F. This water, then, can be cooled to the desired temperature for the defrosting operation. These provisions will not be required if the operator intends using open sea water (which is relatively free of contamination) for defrosting, or if the defrosting operation is performed within an enclosed refrigeration unit located in the fanroom space, apart from the stored cargo.

Section F. PLUMBING

1. MATERIALS. Only new pipe, tubing, or fittings should be used in the potable-water system. Lead pipe and cadmium-lined fittings should not be used.

2. AIRGAPS. An airgap is the unobstructed vertical distance through the free atmosphere between the lowest opening from any supply pipe or fixture drain and the flood-level rim of the receiving receptacle. The length of an airgap should be at least twice the effective diameter of the delivery pipe or drain which it protects. Wher a receiving funnel is provided, the gap should be measured from the top of the funnel to the end of the pipe or drain. (See fig. 7, below.)



AIR GAP FOR POTABLE-WATER SERVICE LINES

Figure 7.

3. BACKFLOW PREVENTERS (VACUUM BREAKERS). When an airgap cannot be provided in the water-supply line to a fixture, a suitable backflow preventer should be installed in the supply line, on the discharge side of the control valve and at least 4 inches above the floor-level rim of the fixture, as shown in figure 8, page 25. The backflow preventer should be so designed that a complete cycle of any moving parts is made each time the control valve in the supply line is opened and closed. Backflow preventers which meet the specifications set forth in *American Standard Backflow Preventers in Plumbing Systems,* 1943 [1] are recommended.

4. BACKWATER VALVE. A backwater valve is a mechanical device installed in a soil or waste line to prevent the reversal of flow under conditions of back pressure. In the check-valve type, the flap should swing into a recess when the line is flowing full, to preclude obstructing the flow.

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[1] American Standards Association, 70 East 45th Street, New York, N. Y.

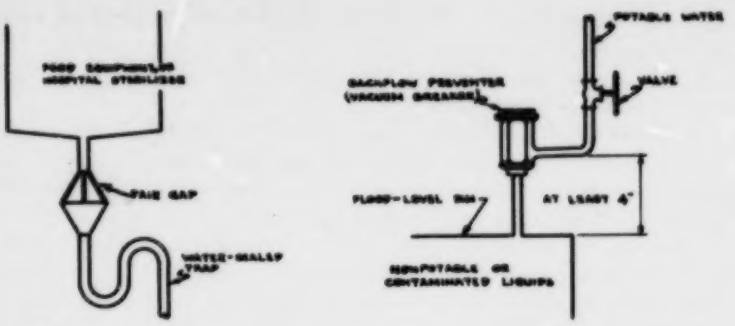

Figure 8.

5. FIXTURES. All fixtures should be resistant to the corrosive effects of salt water and saline atmosphere. Fixtures should be easy to clean, and so designed as to function efficiently. Internal corners of a fixture should be rounded, wherever practicable.

The installation of bidets is not recommended. Any which are installed should be of the jet type; any potable- or wash-water line serving them should be equipped with a backflow preventer.

6. PREVENTION OF BACKFLOW INTO THE POTABLE-WATER SYSTEM. The potable-water system should not be cross-connected to any nonpotable-water system, and no provision should be made for such a connection. Overflows, vents, and drains from tanks, and drains from the distribution system (including any treatment plant), should not be directly connected to sewage drains. When drain lines are extended toward the bottom of the vessel, they should terminate at least 18 inches above the inner-bottom plating, or above the highest point of the bilge in the absence of such plating, unless the hydraulics are such that backflow is impossible. Air-gaps and receiving funnels should be installed in these lines when they discharge to a closed tank of a nonpotable-water system, or to a deck drain or to a sanitary drain.

The delivery of potable water to sinks, wash basins, bathtubs, laundry trays, clothes-washing machines, boiler-water spill-tanks (hot wells), waste-disposal units, hospital equipment, certain equipment used in the preparation or processing of food, or equipment for the washing of eating and drinking utensils, should be through an airgap. Where an airgap is impracticable, a backflow preventer should be installed.

If neither above-the-rim delivery nor a vacuum breaker on the discharge side of the control valve is practicable on a drinking-glass rinser, vegetable peeler, or similar flow-through unit, a 1½-inch or larger waste drain, or an overflow opening at a point at least twice the diameter of the waterpipe

below the water inlet, will be suitable, provided that waste discharge is through an airgap immediately below the unit.

A direct connection of the potable-water system to a coffee urn or to the top of a steam kettle is satisfactory.

7. DRINKING FOUNTAINS. Bowls or basins of drinking fountains and coolers should be constructed of impervious, nonoxidizing material, and should be so designed and constructed as to be easily cleaned and protected against backflow. The jet of a drinking fountain should be slanting, and the orifice of the jet should be protected by a guard in such a manner as to prevent contamination thereof by droppings from the mouth or by splashing from the basin. The orifice of such a jet should be at least three-fourths inch above the rim of the basin.

The water-supply pipe should be provided with a pressure-regulating valve, which will permit the regulation of the flow of water to the fountain, so that the valve manipulated by the user of the fountain will merely turn the water on or off.

The waste opening and pipe should be of sufficient size to carry off the water, and should be provided with a strainer. The drain should be trapped, if it ties into a drainage system.

8. DRAINAGE SYSTEMS. Drains should be of adequate size to prevent clogging and subsequent backflow of sewage or contaminated waste into the fixtures and spaces they serve. Provision should be made to prevent the pipes from freezing.

No drainage line of any kind, nor any pipe carrying wash water, salt water, or other nonpotable liquid, should pass through any potable-water tank, unless as specified in section A, item 6, page 3.

Soil-waste drains should not pass over potable-water-tank manholes. Toilet and bathroom spaces should not extend over any part of a deck which forms the top of a potable-water tank.

Drainage pipes carrying soil waste should not pass directly over, or horizontally through, refrigerated cargo holds, spaces where food is stored or prepared, spaces where utensils are washed, or portions of spaces from which food is regularly dispensed, unless the pipe is of extra-heavy, galvanized steel, or galvanized, standard, wrought iron with welded joints, and is hydrostatically tested for leakage, and provided that there are no cleanouts over such spaces. Joints may be butt-welded, provided that no welding bead remains within the pipe. Butt-welding may be avoided by the application of a sleeve coupling which is welded at the ends of the sleeve.

When water from overboard is treated aboard a vessel for use as potable water, the sanitary overboard discharges should not be on the same side as, nor forward of, the water intake. When this is not possible, the waste discharge should be as high as possible, and the water intake as low and as far forward as possible.

Drainlines carrying sewage, food particles, or other putrescible matter, should not be discharged to the bilge.

An open drain from the potato peeler can be discharged to a sink in any of the food spaces, provided that the sink is not routinely used for washing dishes and utensils.

Deck drains should be provided in all food-preparation and food-storage spaces. The need for such drains in other spaces is subject to the discretion of the designer.

9. VENTS AND TRAPS. Drainage systems which receive sewage, ablutionary water, or other putrescible waste, should have all of the vents and water-sealed traps which may be necessary to prevent gases or obnoxious odors from entering any space served. The water-sealed traps should be so designed as to minimize the deposition of settleable solids. A trap should be of the same size as the drain to which it is connected. When there is an airgap in the drain, the trap should be installed below the airgap. A garbage-grinder drain or a garbage chute may have a backwater valve in lieu of a trap, when it is discharged independently.

10. CLEANOUTS. Cleanout and "rodding" plugs should be installed at appropriate places in the drainage system. Means of opening and cleaning the traps should be provided.

Cleanout and "rodding" plugs should not be installed in those parts of drainage systems which are near potable-water-tank manholes, over spaces where food is stored or prepared or where eating utensils are stored or handled, or in refrigerated spaces.

11. PREVENTION OF BACKFLOW OF WASTE. Individual airgaps should be placed in the drainlines from certain types of fixtures, such as waterbath sterilizers, hospital water stills, autoclaves, steam kettles, drinking-glass rinsers, vegetable peelers, and coffee urns, as well as from all hospital and food-preparation and -servicing equipment which may be subject to subatmospheric pressure.

Airgaps shoud be placed, also, in the individual drainlines from refrigerated-cargo spaces, the ship's-stores refrigerators, dry-stores space, dishwashers, and equipment used in the preparation or processing of food, when such drainage is to a system which receives human sewage [2] or hospital wastes. Individual airgaps will not be required in these drains when one of the following conditions is satisfied:

a. The drains are independent of each other and of all other drainage systems. (See fig. 9.)

b. The drainlines discharge to open drainwells. When the drainline runs from equipment which may be subject to subatmospheric pressure, it should not be submerged in the drainwell.

c. The drains from such equipment and spaces are connected to a common drainage system separate from any system carrying human wastes, and there are telltale deck-drains in each food-storage and food-preparation space; except that a deck-drain outside the space will suffice in refrigerated spaces.

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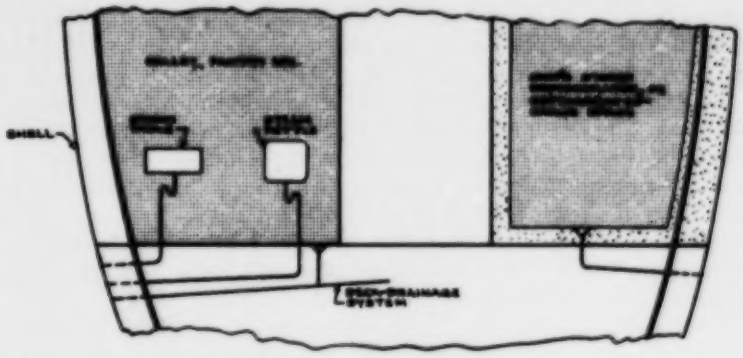
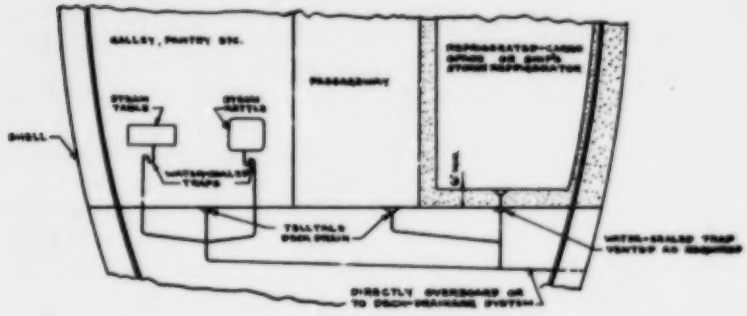
[2] Human sewage is defined as liquid wastes containing human excreta.

In the latter case, the telltale deck-drain should be in an adjacent, frequented space or passageway, and at a level at least 6 inches lower than that of the drain in the floor of the refrigerated space. (See fig. 10.) This system can be connected to a human-sewage or hospital-waste drainage system (as stated in item 12, page 29) for the purpose of having one common overboard discharge.



INDEPENDENT GRAVITY DRAINAGE

Figure 9.

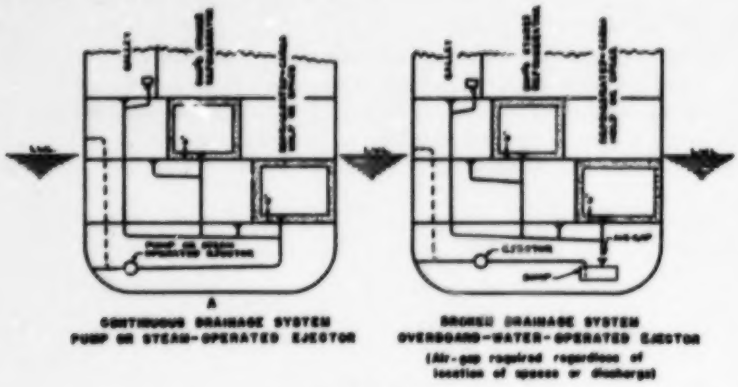


COMBINED GRAVITY DRAINAGE

Figure 10.

Either of the food-waste drainage systems mentioned in a, b, and c, above, may be discharged by gravity, directly overboard or through airgaps, to other drainage systems. Pumps or steam-operated ejectors are satisfactory in continuous drainage systems which discharge above or below the waterline, regardless of the elevation of the spaces drained, provided that telltale, overflow deck-drains are installed as recommended in c, above. (See fig. 11A.) Ejectors which are operated by overboard water should not be installed in continuous systems. When wastes from these food-storage

and -preparation spaces are discharged through an airgap to a sump, ejection from the sump by means of an overboard, water-operated ejector is satisfactory. (See fig. 11B.)



PUMP AND EJECTOR DISCHARGE

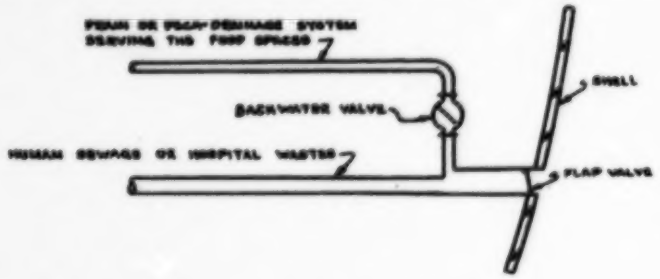
Figure 11.

12. OVERBOARD DISCHARGE CONNECTION. The drainage systems mentioned under par. c, item 11, page 27, can be connected to other systems carrying human sewage or hospital wastes, for the purpose of having one common overboard discharge, provided that the following conditions are met:

a. The connection is adjacent to the shell opening, i. e., about 3 feet from the shell.

b. Each food-waste drain connected to the overboard discharge line is equipped with a backwater valve located adjacent to the connection.

c. The overboard discharge carrying the combined drainage is free of checks and other obstructions (except the usual flap-valve at the shell), and its diameter is not less than the diameter of the largest serviced line,



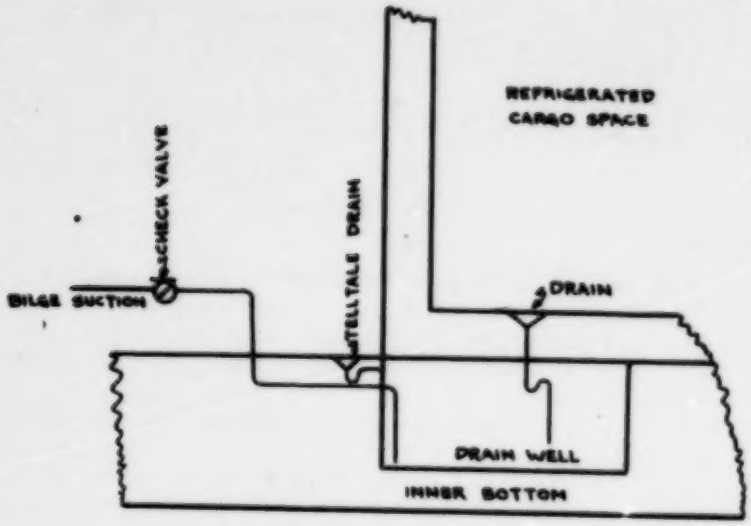
COMBINED OVERBOARD DISCHARGE

Figure 12.

and at least 4 inches in any case. (Valves required for other purposes should be inboard of the junction on the soil line, and inboard of the backwater valve on the food-waste drain.)

d. Telltale, overflow deck-drains are provided in the food-waste system, as specified in par. 11c, page 27.

When a refrigerated space is located on the inner-bottom plating and its drains go to a drainwell which, in turn, is emptied with a separate pump, steam-operated ejector, or bilge pump, a telltale deck-drain should be connected to the drainwell. The telltale drain should be at least of the same diameter as the suction line to the pump. (See fig. 13, below.)



DRAINAGE OF INNER BOTTOM DRAIN WELL
Figure 13.

Section G. SWIMMING POOLS

1. GENERAL. Fill-and-draw swimming pools should not be installed. Recirculating swimming pools should be equipped with filters and chlorinators, and should be constructed in accordance with the recommendations in the latest edition of *Recommended Practice for Design, Equipment, and Operation of Swimming Pools*, published by the American Public Health Association, 1790 Broadway, New York, N. Y. Flowing-through, salt-water swimming pools—the type most practicable for seagoing vessels and their water-supply systems—should be so designed as to provide maximum protection for swimmers.

2. SALT-WATER POOL. The number of bathers that can use a swimming pool safely at one time, and the total number that can use a pool during one day, are governed by the area of the pool and the rate of replacement of its water with clean water. Therefore, the pool should be designed with special attention to the probable peak bathing load and the maximum space available for the construction of a pool. The following principles should be applied in the design of flowing-through, salt-water pools:

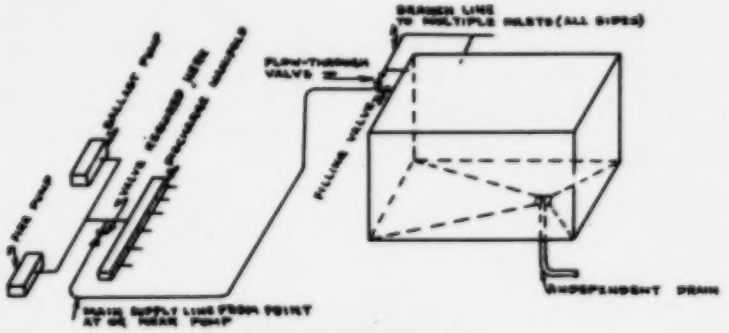


Figure 14.

The design capacity of the pool should be judged on the basis of 27 square feet per bather. For the maintenance of satisfactorily clean water in the pool, the rate of flow of clean sea water should effect complete replacement at least once every 6 hours or less. The flowing-through water should be delivered to the pool through multiple inlets, located so as to ensure uniform distribution. These inlets should be served by a branch

line taking off from the main supply line, at the pressure side of the filling valve near the pool. This branch line should be designed to effect replacement of the water in the pool every 6 hours or less. Control of the flow should be independent of the filling valve.

The overflow should be discharged into scum gutters or a similar boundary overflow, with multiple outlets spaced not more than 10 feet apart, discharging to the waste system.

A drain should be installed at the lowest point in the pool, and drainage facilities should be sufficient to ensure quick emptying. The drains from the pool should preferably be independent; however, when connected to any other drainage systems, a backwater valve should be installed in the swimming-pool drainline.

The bottom of the pool should slope toward the drain or drains in such a manner as to effect complete drainage of the water from the pool. In the interest of safety, the slope of the bottom of any part of the pool in which the water is less than 6 feet deep should be not more than 1 foot in each 15 feet. There should be no sudden change of slope within the area where the water depth is less than 5 feet.

3. WATER-SUPPLY SYSTEM. It is preferable to have a separate water-supply system, including the pump. The water intake should be forward of all sewage outlets from the vessel. However, if the pool will be filled and the flowing through will occur only when the vessel is under way, it will be satisfactory to use the fire or sanitary-overboard-water pumps, or a combination of these pumps, provided that:

a. The delivery line to the pool is independent of other lines originating at or near the discharge of the pump or the valve manifold, or at a point where the maximum or near-maximum flushing of the fire or sanitary-overboard-water pump and main is routinely effected.

b. A readily accessible shutoff valve is located close to the point of take-off from the fire or sanitary-overboard-water system, and is conspicuously labeled CLOSE WHILE IN HARBORS.

Section H. ACCOMMODATIONS

1. GENERAL. Regulations and laws pertaining to passenger and crew accommodations are administered by other Federal agencies. It is axiomatic, however, that accommodations should be such as to protect the health of the occupant and to prevent the introduction, transmission, and spread of communicable diseases

Section I. HEATING, VENTILATING, AND LIGHTING

1. GENERAL. It is beyond the scope of this handbook to set forth standards for these areas. In general, however, heating, ventilating, and lighting should be adequate in living spaces to maintain a healthful and comfortable environment.

Lighting and ventilation, as aids in the maintenance of good sanitary conditions in food-preparation, food-storage, and food-service spaces, should conform to recommendations in section E, items 8 and 9, page 20.

For standards of good practice, reference is made to the following publications:

Heating, Ventilating, Air-Conditioning Guide, American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York 10, N. Y.

IES Lighting Handbook, Illuminating Engineering Society, 51 Madison Avenue, New York 10, N. Y.

Section J. RATPROOF CONSTRUCTION

1. GENERAL. The ratproof construction of a vessel is accomplished by so designing and building it as to eliminate, or to render inaccessible to rats, every space which might afford them harborage to shelter, nest, breed, or obtain food. Open-type construction, which eliminates enclosed spaces, is preferable to "protective" ratproofing. Open-type construction consists of opening to view partially enclosed spaces and locating and arranging service lines, machinery, equipment, furniture, and fixtures so that enclosed or partially enclosed spaces will not be created. Uninspectable places and void spaces, including those filled with insulation, should be made ratproof.

When nonratproofing material is installed, it can be made resistant to rats by covering it completely with a ratproof material, or by flashing any gnawing edges, as hereinafter specified.

The control of rat infestation on vessels is concerned, also, with preventing the passage of rats from one section of a vessel to another. Such sections as cargo holds, engine rooms, forepeaks and afterpeaks, chain lockers, tonnage and bunker spaces, auxiliary-machinery spaces, storage spaces, refrigerated spaces, galleys, and pantries, should be completely isolated by means of dependable ratproofing.

2. MAXIMUM OPENINGS. All openings, snipe and drain holes, and slots should be no larger than one-half inch.

3. RATPROOFING MATERIALS. Materials used for ratproofing should be resistant to the gnawing of rats. Lead, wood, certain fiber boards, plaster boards, and similar materials are *not* resistant to gnawing. Materials which are suitable for ratproofing, within spaces hereinafter indicated, provided that they are thick enough to resist tearing by rats and to withstand any blows to which they may be subjected, include steel plate, sheet iron or steel,[1] sheet aluminum or metal alloy of suitable hardness and strength, perforated sheet iron, expanded metal, flattened expanded metal, wire or hardware cloth, and metal lath. All steel should be galvanized or painted.

Expanded metal, flattened expanded metal, and wire mesh used for ratproofing should have openings no greater than one-half inch.

Metal lath should have no openings greater than one-half inch, and its finished weight should be at least 3.4 pounds per square yard. Ribbed metal lath should be used where additional strength is needed.

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[1] The term *sheet iron*, when used hereinafter, will include sheet metal generally.

Aluminum with the following tempers and alloys will be acceptable: 52S–¼H, 52S–½H, 52S–¾H, 61S–W, and 61S–T. When aluminum is substituted for sheet iron, it should have a thickness by the Brown and Sharpe gauge [2] next greater than the thickness specified by U. S. Standard for sheet iron. For example, aluminum of 16-gauge (Brown and Sharpe) is suitable to replace sheet iron of 18-gauge (U. S. Standard).

Cements, putties, certain plastic sealing compounds, and lead should not be used in lieu of metal ratproofing materials, except that hard-setting cement may be suitable for closing openings around cables within ferrules at bulkheads.

4. ACCEPTABLE NONRATPROOF MATERIALS. Certain nonratproof materials are satisfactory in some spaces, provided that the boundaries and miscellaneous gnawing edges are flashed, as recommended in item 5b, page 36. Wood and asbestos composition materials are acceptable under the following conditions:

a. Wood should be dry or seasoned, and free of warps, splits, and knots. Plywood should be resin-bonded and waterproof.

b. The following inorganic, asbestos compositions, with the minimum physical properties indicated, will be satisfactory in certain spaces. These composition sheets and panels are relatively strong, hard, and with surfaces which are smooth and resistant to the gnawing of rats. The edges of these sheets and panels, except the approval metal laminates, are gnawable. The approved metal laminates are ratproof, and no other protection is necessary.

(1) Asbestos-cement panel (rigid):	
Thickness	¼" to 1".
Surface hardness (Brinell, 500-kg. load, 10-mm. ball, 10 sec.).	20, min.
Modulus of rupture, ultimate	4,000 p. s. i., min.
(2) Asbestos-cement sheet (flexible):	
Thickness	⅛" to 3/16".
Surface hardness (Brinell, 500-kg. load, 10-mm. ball, 10 sec.).	18, min.
Modulus of rupture, ultimate	5,000 p. s. i., min.
(3) Asbestos insulating panel:	
Thickness	⅜" to ⅞".
Surface hardness (Brinell, 50-kg. load, 10-mm. ball, 10 sec.).	1.8, min.
Modulus of rupture, ultimate	800 p. s. i., min.
(4) Metal-laminated asbestos-cement sheet:	
Thickness	3/16" to ¼".
Surface hardness (Brinell, 500-kg. load, 10-mm. ball, 10 sec.).	18, min.

[2] Gauges given herein are U. S. Standard for sheet iron and expanded metal, Brown and Sharpe for aluminum, and American Steel & Wire for wire cloth.

Modulus of rupture, ultimate	8,500 p. s. i., min.
Metal: Sheet steel, galv., 24 ga., minimum. Aluminum, .032", minimum.	

(5) Faced asbestos insulating panel:

Thickness	½" to ⅞".
Surface hardness (Brinell, 500-kg. load, 10-mm. ball, 10 sec.).	18, min.
Modulus of rupture, ultimate	1,800 p. s. i., min.

Facings: Acceptable asbestos-cement sheet. Sheet steel, galv., 24 ga. (other gauge will be considered). Aluminum, .025", minimum. Other, such as paper, fabrics, wood veneers, etc., will be considered.

5. RATPROOFING OF NONRATPROOF SURFACES. Although metal construction is recommended, certain nonratproof materials may be used satisfactorily after they have been properly ratproofed. Both exposed surfaces of all double bulkheads or deckheads with void spaces greater than three-fourths inch thickness should be ratproofed. For a void space of three-fourths inch or less in thickness, no ratproofing is necessary. Where ratproofing of a single bulkhead is required, only one surface needs to be protected; the ratproofing material should be placed on that surface of the bulkhead which is outside the space being ratproofed. In the case of double bulkheads, it is preferable that ratproofing material be placed on visible surfaces, to facilitate inspection. When appearance is a primary factor, ratproofing material may be concealed. It may be placed between contacting layers of the nonratproof material, or behind it if placed in direct contact with the back of the material being ratproofed.

The following are acceptable methods of ratproofing nonratproof surfaces:

a. *Complete coverage.* The most dependable ratproofing of surfaces of nonratproof materials which cover void spaces or insulation, or which form the perimeter of certain stowage spaces, is complete coverage with sheet iron, or complete backing with expanded metal, flattened expanded metal, or wire mesh. Protection of this type is especially recommended in spaces, such as cargo holds and stowage spaces, where the surface is vulnerable to damage, where almost any part of the surface is exposed to approach by rats regularly or periodically, or where food is readily available.

Where complete coverage is impractical, protective ratproofing of such surfaces by flashing the boundaries and gnawing edges is satisfactory.

b. *Flashing.* Flashing, as herein discussed, should consist of capping or covering corners, boundaries, and gnawing edges with a strip of sheet iron or other material which is resistant to gnawing. The ratproofing may consist of a strip of sheet iron on the surface of the nonratproof material, between layers of it, or behind it; or of ½-inch-mesh hardware cloth or expanded metal between layers of the nonratproof material or immediately

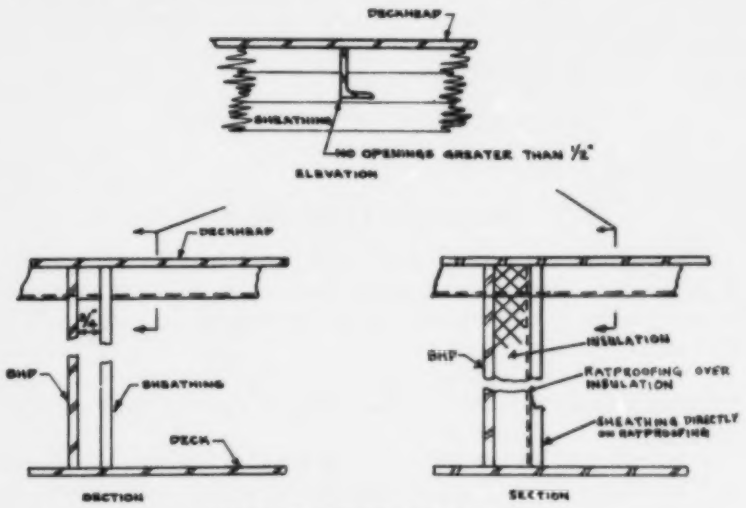
behind it. The flashing strip should be wide enough to cover the gnawing edge or edges adequately, and to ensure the firm fastening of the borders of the flashing material. Flashing need not be placed over tightly fitted tongue-and-groove, shiplap, or similar overlapping joints, except where such joints are within 6 inches of a deck or floor grating or horizontal ledges.

In cargo spaces where fitting is close and difficult, such as around structural members, sheet iron of a next-lighter, even gauge than that recommended for the space will be satisfactory, provided that it will not be subjected to damaging blows and will extend at least 3 inches beyond the member.

c. *Collars.* The perimeter of an opening in nonratproof materials, caused by the penetration of structural members and service lines, should be ratproofed by placing a sheet-iron collar around the penetrating fixture and fastening it to the penetrated surface. The collar should be wide enough to cover the gnawing edge, and should be fitted to within one-fourth inch of the penetrating fixture.

Penetrations of steel-wire cloth or expanded metal need not be collared when the material is fitted around the penetrating fixture so as to leave no opening greater than one-half inch. For sleeve and collar arrangement on insulated surfaces, see item 48, page 64.

6. RATPROOF-EXEMPT SURFACES. Nonratproof sheathing need not be ratproofed when placed flush against, or not more than three-fourths inch from, steel plate, or flush against ratproofing material over insulation.

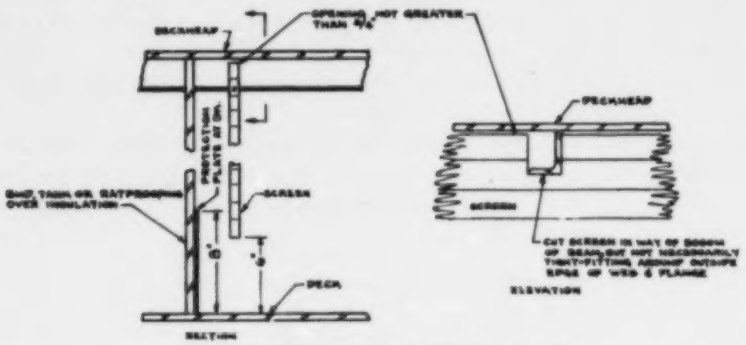


RATPROOF EXEMPT SHEATHING

Figure 15.

Overlapping joints or minimum thicknesses are not necessary for sheathing so placed.

Wooden-screen bulkheads need not be ratproofed when placed flush against, or not more than three-fourths inch from, steel plate or ratproofing material (see fig. 16, below), or so constructed that the screen bulkhead is on at least 4-inch vertical bearers, terminates at least 6 inches above the deck or other horizontal ledge which may be behind or intersect it, and the top of the screen is extended to within three-fourths inch of the deckhead, but is not extended into the bosoms of the beams, girders, or brackets. When so constructed, overlapping joints in the screen bulkhead are not necessary. If additional protection is required for the bulkhead, tank-side, or ratproofing over insulation, behind the 6-inch opening at the bottom, a strip of ⅛-inch plate or heavier sheet iron should be placed over this surface. The sheet iron should be at least 2 inches wider than the opening at the bottom. From a ratproofing standpoint, this type of screen bulkhead is preferable to metal-sheathed or flashed types.



RATPROOF-EXEMPT SCREEN BULKHEAD

Figure 16.

DETAILED RATPROOFING

7. HULL AND SUPPORTS. Shell and bulkhead stiffeners, including structural members over doors and cargo ports, should be installed toe down wherever practicable, to eliminate the partially hidden area formed behind the flange when it is placed toe up.

When deep recesses cannot be easily inspected, or when structural pockets are created by the intersection or close approach of several structural members, the space should be enclosed.

8. LIGHTENING HOLES AND VOID SPACES. Lightening holes, when used as a means of opening spaces and making surfaces visible, should be employed only where they open the space sufficiently to make it easily visible and, thus, unattractive to rats as a nesting place. In no case should

the cutting of lightening holes be recommended where the strength of structural members will be affected adversely.

Void or concealed spaces, such as cofferdams, spaces around the chain lockers or tanks and between the breasthooks, and spaces opened by lightening holes, either should be made accessible, easy to inspect, and open to light, or should be adequately ratproofed. Such a space, when intended for the stowage of dunnage, gear, or miscellaneous material, should be enclosed and provided with hinged entrance doors or manhole covers, with means of securing them. It is preferable that such doors and manhole covers should be hinged at the top and should be self-closing. If made of mesh material, the cut edges should be substantially bound with steel bars or sheet metal crimped over the edges. Drain or ventilation holes or slots in solid sheet-metal skirts around void spaces should be no greater than one-half inch.

Void spaces around, under, and over tanks and other fixtures should be left open, if inspectable from at least two sides. (This, of course, does not apply in food-storage and food-preparation areas, where the requirements for sealing void spaces are more stringent.)

Steel-plate stiffeners located in portions of the fore or after peak which are not within the tanks, and in which lightening, access, or structural holes are present, should have a half-moon with at least a 6-inch radius cut in the stiffener above the breasthook or deck. Such void spaces which create potential rat harborage should be ratproofed.

9. STEEL TANK-TOPS IN LOWER HOLD. Where practicable to do so, the steel tank-top should be extended to the ship's side, to avoid the creation of an open bilge space and the need to install a bilge ceiling. Pipes at the ship's side can be protected by battens. Cover plates over open drainwells should be perforated or slotted.

10. CHAIN LOCKERS. Chain lockers should be designed to retain any rats which might enter by way of the chain pipe. The bulkhead surrounding the locker should be of metal, and should have no holes larger than one-half inch. A bulkhead dividing the locker into two compartments need not be ratproofed. Entrance doors into a chain locker, and lightening holes into the spaces on each side of the locker, should be of ratproof construction. When the chain-storage space is not partitioned from the forepeak, the entire space should be considered the chain locker, and any stowage lockers located in this space should be ratproofed.

11. TANK-TOP CEILINGS. Fixed or portable tank-top ceilings, preferably, should not be installed; if used, they should be placed in direct contact with the tank-top or on ⅜-inch, flat-bar bearers. In no case should the space between the ceiling and the tank-top be greater than three-fourths inch. When thicker bearers are placed under a fixed ceiling, the space in excess of three-fourths inch should be filled with asphalt cement, or bituminous, or some other material which is impenetrable by rats.

12. WOODEN CARGO PADS. Wooden cargo pads in general-cargo holds should be installed as specified above for tank-top ceilings. Cargo

ramps should be constructed of steel plate; if wooden, they should be completely covered with 11-gauge sheet iron when the space beneath is greater than three-fourths inch. (See fig. 17, below.) Wooden cargo pads over cork insulation in refrigerated-cargo holds should be at least 2⅜-inch-thick tongue-and-groove or shiplap, and should be bound with steel. It is preferable that 18-gauge or heavier steel-wire cloth be placed between the ceiling and the cork, but a ceiling with tightly fitted shiplap or caulked butt joints is acceptable.

WOODEN CARGO PADS

Figure 17.

13. BILGE CEILINGS. If possible, bilge ceilings should be eliminated, and open-type protection (such as battens) should be provided for frame brackets, pipe, and similar appurtenances. Permanent bilge ceilings, if required, should be constructed of steel plates wherever practicable. Drainage openings should be provided by using plate perforated with holes not exceeding one-half-inch in diameter.

When wood is used for bilge ceilings, it should be at least 2⅜ inches thick, and should be completely covered with sheet metal of at least 16 gauge.

A ceiling which is composed of a series of portable panels should have each panel completely covered with sheet metal of at least 16 gauge. With this type of construction, the sheet metal covering the fixed wooden ceiling, and that over the portable panel, should extend to the underside of the members, and should be securely fastened so that the edges of the sheet metal will not be exposed.

14. DECKHEAD AND SHAFT-ALLEY CEILINGS. Deckhead and shaft-alley ceilings, when installed, should preferably be of metal. When a wooden ceiling is installed, it should not come into contact with, nor within ¾-inch of, the deckhead plating, and should be constructed of tongue-and-groove or shiplap at least 2 inches thick. The gnawing edges should be flashed with 16-gauge metal.

15. FLOORING. Raised flooring is particularly hazardous from a rat-infestation standpoint, unless the space beneath it is less than ¾ inch. Allowance should be made for the welding beads of butt joints, and for the difference in the elevation of plates which are lap-welded. In some cases, the adjustment can best be made by the use of ½-inch hardwood or ⅜-inch metal bearers.

Solid, portable flooring is objectionable from a general sanitary standpoint, but may be acceptable, provided that:

a. It meets the ratproofing recommendations for raised flooring;
b. It is substantially built; and
c. All sections are of such size and weight as to be easily handled.

In general-cargo holds, each portable section should not exceed 75 square feet in area, and should be provided with at least one flush ring for the attachment of a hoist cable.

Flooring over cork or similar insulation, including concrete and special composition flooring, is discussed in item 25e, page 45.

16. DECK GRATINGS. Deck gratings, when installed, should be so constructed as to create no rat harborage, nor spaces for the collection of food or debris. The slots and holes in the gratings should be no smaller than one-half inch.

All deck gratings which cannot be handled by hoist cable should be in portable sections exceeding neither 36 square feet in area nor 120 pounds in weight, to facilitate removal by one man.

17. SHAFTWAYS. Elevator or dumbwaiter shaftways should be so constructed that there will be no openings into double bulkhead or deckhead spaces, and no easy access to other parts of the vessel.

18. DOORS. Doors of nonratproof material which lead into stowage spaces should be closely fitted, and flashed on the outside lower edge with a 6-inch-wide strip of 22-gauge or heavier sheet iron. (Crash strips should be installed, if essential to ratproofing.) When casings of such doors are installed in openings in double bulkheads, the casings should be ratproofed from the deck to a point at least 6 inches above the sill of the doorway. Either the casing should be flashed on the outside with 22-gauge sheet iron, or 18-gauge hardware cloth should be placed directly behind the casing and in contact with its inner surface.

Construction holes which may be left in the top and bottom edges of prefabricated metal doors need not be ratproofed.

Slots in louvers, and the space between the sill and the bottom of entrance doors and of doors within living quarters, dining rooms, and other public spaces leading to passageways, should be one-half-inch or less ($\frac{1}{16}$-inch tolerance permitted), but this space limitation is not essential for entrance doors to toilets, bathrooms, and wardrobes within these spaces.

Recesses for sliding doors should be ratproofed.

19. WINDOW CASINGS. Window casings in double walls or bulkheads should be of tight construction, and preferably of metal. If not ratproof, there should be no space larger than one-half inch between the window sash or glass and the edge of the opening, whether the window is open or closed. For a window which does not slide in a tight groove, this opening should be limited to one-fourth inch on each side of the sash or glass, to avoid an opening exceeding one-half inch when the window shifts to one side. (This is not necessary for a window well which is ratproof.) For a window sash which does not drop to within one-half inch of the well, a removable inspection panel should be provided. Windows that slide

horizontally into a double well or bulkhead should pass into a pocket, constructed in the same manner as the window well recommended above.

20. BALLAST. Permanent ballast should be so installed as to avoid the creation of rat harborage. Solid block, gravel, or sand ballast should be completely sheathed with a layer of reinforced concrete or cement mortar of adequate thickness. Wooden sheathing for permanent gravel, sand, or block ballast should be at least 2⅝ inches thick in finished size. Sheathing with square butt joints should have its entire surface covered with metal. Horizontal surfaces on which cargo is placed, particularly under cargo hatches, should be covered with steel plate. If flashed instead of being completely covered with sheet metal, the sheathing should be shiplap or tongue-and-groove. The lining of access manhole wells should be ratproofed in the same manner, and the edges of the covers of these wells should be completely bound with 16-gauge or heavier sheet metal. Structural steel angles should be used at vulnerable corners in cargo holds.

21. LIGHTING TROUGHS. Troughs for indirect lighting in public places should not be continuous through any bulkhead or partition. Troughs which are not closed at each end and within each space should have ratproofing material placed over the opening at the bulkhead or partition. An electric cable entering from a double bulkhead, or through the boundary of a ratproof space, should be collared.

22. SKYLIGHTS. Skylights in food-storage and food-service spaces should be screened with ½-inch-mesh, steel-wire cloth of a gauge suited to the span, space, and exposure, but in no case less than 18-gauge. Other skylights, except those over engine rooms, should be screened where essential. Copper or other corrosion-resistant insect screens are not ratproof; when used, they should be supplemented by heavy-mesh wire or expanded metal.

23. MANHOLES. Manhole protective covers or guards, preferably, should be made of steel plate, with no opening greater than one-half inch. When made of wood, and when the void spaces created when the unit is in place are greater than three-fourths inch in any dimension, the entire inside should be lined with 22-gauge sheet iron. Only flashing of the gnawing edges will be required if tongue-and-groove or plywood is used.

SPECIAL RECOMMENDATIONS FOR PARTICULAR SPACES

The following information supplements that contained in items 1 through 23 of this section.

24. GENERAL-CARGO HOLDS. a. *Complete coverage:* Where complete coverage of nonratproof surfaces is necessary, sheet metal should be at least 16-gauge on bulkhead surfaces, and at least 18-gauge on the deckhead.

b. *Flashing.* All gnawing edges should be covered with at least 16-gauge sheet metal. Heavy angle bars may be necessary in areas subject to severe damage. Flashing should extend at least 6 inches above a stand-

ing surface at the deck, and should overlap other horizontal and vertical gnawing edges by at least 3 inches. Wooden strips or molding should not be used in lieu of metal flashing.

Whenever a wooden cargo pad, a portable wooden flooring, or a temporary installation of concrete ballast touches or is near wood sheathing or a screen bulkhead, the flashing should extend from the steel deck to a point at least 6 inches above the upper surface of the cargo pad, flooring, or concrete.

c. *Composition Materials.* Cement- and asbestos-composition boards, as now manufactured, are not suitable for use in general-cargo holds because of the severe blows to which they may be subjected. Material which is faced with metal may be acceptable.

d. *Storage Locker.* Single-partition bulkheads within general-cargo holds, which are used to protect against theft of special cargo, need not be ratproofed.

e. *Tonnage openings.* Tonnage openings in cargo-hold bulkheads leading to public spaces should be ratproofed. Battens of wood should have the edges of each piece bound with 16-gauge sheet metal. Tonnage openings between cargo spaces need not be ratproofed.

f. *Miscellaneous.* Materials which are to be used elsewhere in cargo holds, to cover uninspectable areas, should be of at least 16-gauge sheet metal (12-gauge, if perforated), 12-gauge expanded metal (12 to 14, if flattened), or 11-gauge wire mesh.

References:

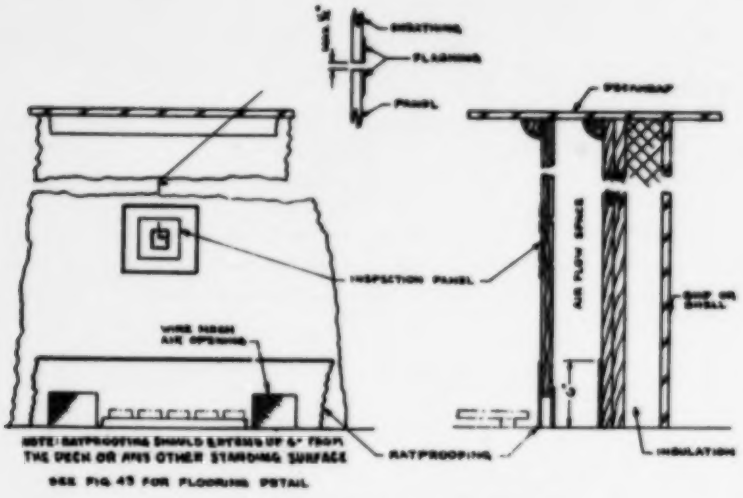
Manholes	Item 23, p. 42.
Tank-Top Ceilings	Item 11, p. 39.
Wooden Cargo Pads	Item 12, p. 39.
Bilge Ceilings	Item 13, p. 40.
Spare-Parts Boxes	Item 59, p. 68.
Flooring	Item 15, p. 40.
Deck Gratings	Item 16, p. 41.
Ballast	Item 20, p. 42.
Battens	Item 33, p. 53.
Plate Guards	Item 34, p. 53.
Wireway and Cable Guards	Item 35, p. 54.
Vent Screens	Item 40, p. 60.
Service Facilities	Items 36, 37, 38, 39, pp. 56–59
Screen Bulkheads	Item 6, p. 37.
Insulation	Items 41, 42, 43, pp. 62–63.

25. REFRIGERATED CARGO HOLDS—COIL OR AIR-COOLED.

a. *Sheathing.* **Metal sheathing:** without batten protection—18-gauge sheet metal; with batten protection—22-gauge sheet metal. **Wood sheathing:** tongue-and-groove or shiplap (2 layers acceptable)—1½ inches; plywood—1 inch; combination of tongue-and-groove or shiplap and plywood—

1⅜ inches. **Composition board** (see item 4, p. 35): asbestos-cement panel (rigid), without batten protection—½-inch; with batten protection—⅜-inch; steel-laminated asbestos-cement sheet—¼-inch; aluminum-laminated asbestos-cement sheet—¼-inch.

b. *Bulkheads—noncatwalk type.* **Wood:** tongue-and-groove or shiplap (2 layers acceptable)—1⅜ inches; plywood—1 inch; combination plywood and tongue-and-groove or shiplap—1 inch. **Composition board** (see item 4, p. 35): asbestos-cement panel (rigid)—½-inch; steel-laminated asbestos-cement sheet—as manufactured; aluminum-laminated asbestos-cement sheet—as manufactured.



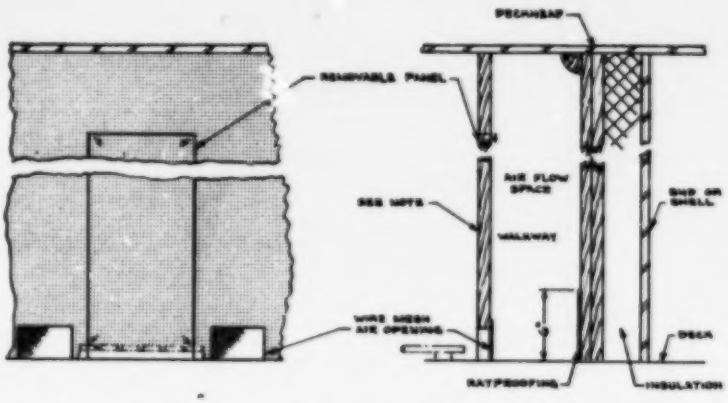
NONCATWALK-TYPE AIR DUCT

Figure 18.

Catwalk-type and cooler-room bulkheads should be substantially built, but not necessarily ratproofed. To prevent the passage of rats from one area to another, there should be no openings greater than one-half inch.

c. *Flashing.* All gnawing edges of nonratproof sheathing, blowout plugs, flood plugs, and inspection panels should be flashed: external corners—18-gauge sheet metal; internal corners—22-gauge sheet metal or 1⅜-inch quarter-round molding.

Composition material should be flashed as follows: The gnawing edges of asbestos-cement panel (rigid) should be protected by a channel or metal molding which will overlap the edge by at least one-half inch. Sheet-metal backing will be acceptable, provided that it overlaps each gnawing edge by 1 inch. Aluminum-laminated asbestos-cement sheet should be flashed similarly. Steel-laminated asbestos-cement sheet will require no further ratproofing.



NOTE: THIS SURFACE TO BE RAT-PROOF RESISTANT TO THE EASY PASSAGE OF RATS

CATWALK-TYPE AIR DUCT

Figure 19.

Flashing around insulated, free-standing stanchions should be of 11-gauge metal attached with countersunk screws (or equal thereto).

Wooden sheathing over insulation, or void spaces opposite inclined baffles, or horizontal ledges within air ducts, need not be flashed, provided that seams and joints therein are tight.

d. *Battens.* Where batten protection of a ratproof, exposed surface is needed, it should be as recommended in item 33, page 53, except that vertical battens of 1⅝ inches by 1⅝ inches or larger may be placed directly on solid sheathing.

e. *Flooring.* Flooring of concrete or of hard composition material, over voids of insulation thicker than three-fourths inch, should be not less than 2 inches thick, and should be reinforced with large-mesh material. When a flooring consists of a layer of concrete and a layer of composition material, the concrete should be at least 1½ inches thick, and one of the layers should be reinforced. In all cases, the cove at the boundaries, and the curb or sheathing above the flooring and grating, should be ratproofed. When the bulkhead sheathing is of wood, the cove should be ratproofed by placing ½-inch, 18-gauge wire mesh (½-inch, 18- to 20-gauge flattened metal, or 18-gauge expanded metal will be acceptable) 4 inches into, or on the bottom of, the composition flooring, and extending it up 6 inches above a standing surface in the space. When the top of the curb is less than 6 inches above the top of the deck grating (or of the deck, in the absence of a grating), the lower portion of the sheathing should be ratproofed up to the height of the curb, and a zee bar could be placed on the exposed surface of the sheathing up to the prescribed height. (See fig. 20, p. 46.)

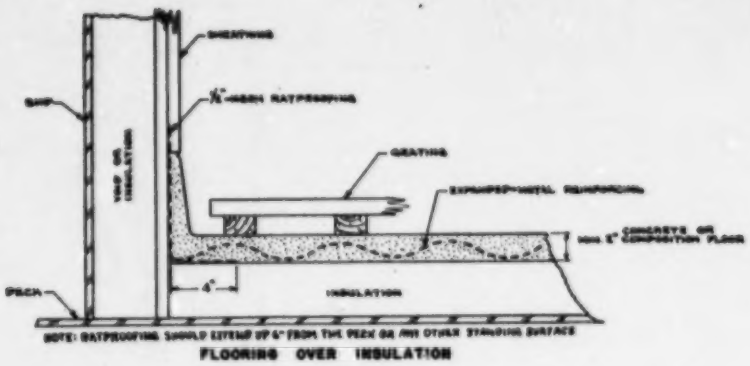


Figure 20.

When the bulkhead sheathing is of asbestos-composition board, such as metal-laminated asbestos-cement sheet, some ratproofing can be eliminated, depending on the type of construction.

f. *Air outlets.* The air outlets on ports should be covered with at least 16-gauge perforated metal, 16-gauge expanded metal, 16- to 18-gauge flattened expanded metal, or 14-gauge wire cloth.

g. *Miscellaneous.* For miscellaneous metalwork in these spaces, use 18-gauge sheet metal, 16- to 18-gauge flattened expanded metal, 18-gauge expanded metal, or 14-gauge wire mesh.

References:

Deck Gratings	Item 16, p. 41.
Battens	Item 33, p. 53.
Plate Guards	Item 34, p. 53.
Service Facilities	Items 36, 37, 38, 39, pp. 56–59.
Vent Screens	Item 40, p. 60.
Insulation—Refrigerated-Cargo Spaces	Items 41, 44, pp. 62, 64.
Insulated Sleeves	Item 48, p. 64.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Wooden Cargo Pads	Item 12, p. 39.
Refrigerated-Machinery Spaces	Item 45, p. 64.

26. SHIP'S-STORES REFRIGERATOR.

a. *Sheathing.* **Metal sheathing:** 22-gauge sheet metal. **Wood sheathing:** tongue-and-groove or shiplap (2 layers acceptable)—1½ inches; plywood—seven-eighths inch; combination tongue-and-grove or shiplap and plywood—1⅛ inches. **Composition boards** (see item 4, p. 35): asbestos-cement panel (rigid), bulkhead—three-fourths inch; deckhead—one-half inch; metal-laminated asbestos-cement sheet—as manufactured.

b. *Alternate Sheathing.* Metal lath (3.4# per square yard) with a hard-finished coating will be acceptable. In place of metal lath, 18- to 20-gauge flattened or 18-gauge expanded metal may be used.

c. *Flashing.* All gnawing edges of nonratproof sheathing should be flashed: external corners—22-gauge sheet metal; internal corners—22-gauge sheet metal or 1⅜-inch quarter-round molding. Flashing of composition material will be similar to that outlined in item 25c, page 44.

d. *Flooring.* See item 25e, page 45.

e. *Miscellaneous.* For miscellaneous metalwork in these spaces, use 22-gauge sheet metal, 18- to 20-gauge flattened expanded metal, 18-gauge expanded metal, or 14-gauge wire mesh.

References:

Battens, Plate Guards	Items 33, 34, p. 53.
Deck Gratings	Item 16, p. 41.
Service Facilities	Items 36, 37, 38, 39, pp. 56–59.
Vent Screens	Item 40, p. 60.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Insulated Sleeves	Item 48, p. 64.
Insulation	Items 25e, 41, pp. 45, 62.

27. STOWAGE SPACES.

a. *Sheathing.* **Metal sheathing:** 18-gauge sheet metal. **Wood sheathing:** tongue-and-groove or shiplap—¾-inch; plywood—¾-inch; combination tongue-and-groove or shiplap and plywood—1 inch. **Composition board** (see item 4, p. 45; asbestos-cement panel (rigid)—½-inch; faced asbestos insulating panel—½-inch.

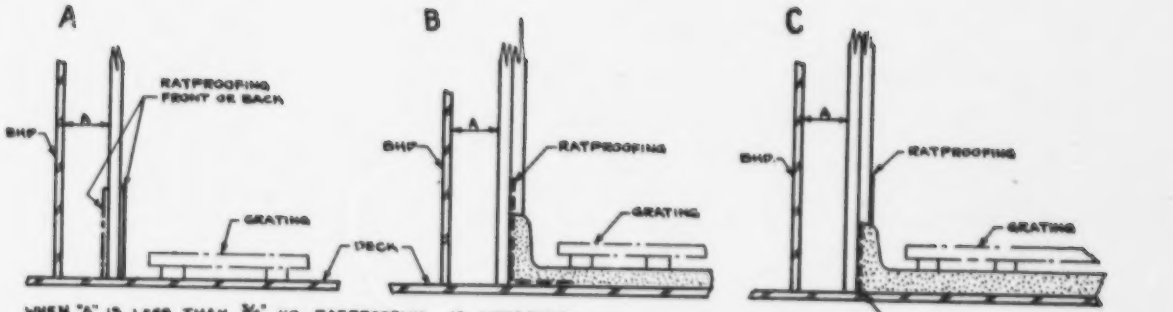
b. *Flashing* (except deck). All gnawing edges of wood sheathing should be flashed with at least 22-gauge sheet steel. For composition material: Asbestos-cement panels, aluminum-laminated asbestos-cement sheets, and aluminum-faced or asbestos-cement-faced insulating panels will require only gnawing-edge protection as outlined in item 25c; steel-laminated asbestos-cement sheets or steel-faced insulating panels will require no further protection.

c. *Flashing at deck.* Nonratproof sheathing within 6 inches of the deck or deck covering should be ratproofed. Where portable flooring or grating is installed, the ratproofing material should be extended upward to a point 6 inches above the standing surface.

When ratproofing is placed behind a deck covering, the material should be attached to the deck or imbedded in the deck covering, as shown in figure 21, page 48. Where the ratproofing is placed in back of the sheathing, it should extend 6 inches above the standing surface on the space side of the sheathing. (See fig. 21, p. 48.)

d. *Doors.* Doors should have no openings greater than one-half inch. No tolerance will be acceptable (over the one-half inch) between the door and the sill. (See item 18, p. 41.)

e. *Subdivisional bulkheads.* Single subdivisional bulkheads in stowage spaces need not be ratproofed, unless some purpose, other than compartmentation, will be served by such ratproofing.



WHEN "A" IS LESS THAN 3/8" NO RATPROOFING IS NECESSARY.
NOTE: RATPROOFING SHOULD EXTEND UP 6" FROM THE DECK OR ANY OTHER STANDING SURFACE

RATPROOFING AT DECK

Figure 21.

f. *Miscellaneous.* For miscellaneous metalwork in these spaces, use 18-gauge sheet metal, 18-gauge expanded metal, 18- to 20-gauge flattened expanded metal, or 14-gauge wire mesh.

References:

Shelves and Bins	Items 56, 57, pp. 67, 68.
Boxes	Item 61, p. 68.
Insulation	Item 41, p. 62.
Deck Gratings	Item 16, p. 41.
Service Installations	Items 36, 37, 38, 39, pp. 56–59.
Vent Screens	Item 40, p. 60.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Doors	Item 18, p. 41.
Flooring	Item 15, p. 40.
Furniture and Fixtures	Item 62, p. 69.
Carbon Dioxide Containers	Item 58, p. 68.
Insulated Sleeves	Item 48, p. 64.
Spare-Parts Boxes	Item 59, p. 68.

28. GALLEYS, PANTRIES, AND OTHER FOOD-PREPARATION SPACES.

a. *Bulkheads.* Bulkheads and deckheads in these spaces should have hard, smooth-finished surfaces, preferably of sheet metal, and should have tight seams.

b. *Sheathing.* **Metal sheathing:** 22-gauge sheet metal. **Wood sheathing:** tongue-and-groove or shiplap—¾-inch; plywood—¾-inch. **Composition boards** (see item 4, p. 45): asbestos-cement panel (rigid)—⅜-inch; faced asbestos insulating panel—⅜-inch.

These materials and $^{3}/_{16}$-inch asbestos-cement sheet (flexible) are satisfactory for use as deckhand sheathings, except that perforated asbestos-cement sheet (flexible) deckhead sheathing will not be acceptable in food-preparation spaces.

c. *Flashing* (except deck). All gnawing edges of wood sheathing should be flashed with 22-gauge sheet metal. Composition boards should be flashed as follows: Asbestos-cement panel (rigid), aluminum-faced or asbestos-cement-faced insulating panel will require gnawing-edge protection, as indicated in item 25c, page 44. Metal-faced insulating panel will require no further protection.

d. *Flashing at deck.* (See item 27c, p. 47.)

e. *Doors.* (Similar to item 27d, p. 47.)

f. *Subdivision bulkheads.* Subdivisional bulkheads in galleys and pantries need not be ratproofed nor made resistant in any way to the passage of rats.

g. *Miscellaneous.* For miscellaneous metalwork in these spaces, use 22-gauge sheet metal, 18- to 20-gauge flattened expanded metal, 18-gauge expanded metal, or 14-gauge wire mesh.

References:

Deck Gratings	Item 16, p. 41.
Shaftways	Item 17, p. 41.
Vent Screens	Item 40, p. 60.
Skylights	Item 22, p. 42.
Insulation	Items 41, 47, pp. 62, 64.
Electric Refrigerators	Item 65, p. 70.
Insulated Pipes and Vents	Items 49, 50, pp. 64–66.
Furniture and Fixtures	Item 62, p. 69.
Shelves and Bins	Items 56, 57, pp. 67–68.
Service Installations	Items 36, 37, 38, 39, pp. 56–59.
Galley Fixtures	Item 64, p. 69.

29. LIVING ROOMS, DINING ROOMS, AND OTHER PUBLIC SPACES.

a. *Bulkheads.* Single bulkheads around, or single partitions within, these spaces need not be ratproofed, but should be made resistant to the easy passage of rats. Holes greater than one-half inch may be closed with material of which the bulkhead is made, or with any other suitable material.

b. *Sheathing.* **Metal sheathing:** 22-gauge sheet metal. **Wood sheathing:** tongue-and-groove or shiplap—¾-inch; plywood—½-inch. **Composition boards** (item 4, p. 45): asbestos-cement panel (rigid)—⅜-inch; asbestos-insulating panel—⅜-inch; faced asbestos insulating panel—⅜-inch; curved asbestos-cement sheet (flexible)—$^3/_{16}$-inch; asbestos-cement sheet (flexible), faced with metal—$^3/_{16}$-inch.

Note: The $^3/_{16}$-inch curved asbestos-cement sheet (flexible) is acceptable as a bulkhead sheathing in public spaces only if supported on furring spaced 24 inches or less, and if the surface is protected, from the deck up to chair height, with ratproofing or by furniture and fixtures placed against it.

Asbestos-cement sheet (flexible), perforated or solid, is acceptable as a straight lining in public spaces only when backed with ½-inch 18-gauge wire mesh.

The above asbestos-composition materials, including $^3/_{16}$-inch asbestos-cement sheet (flexible), solid or perforated, are acceptable as deckhead sheathing, with the following qualifications:

When $^3/_{16}$-inch perforated asbestos-cement sheet (flexible) is used as a deckhead sheathing in living and dining spaces, there should be no areas to which rats may have access, from ledges formed by girders, beams, pipes, cables, or ventilating trunks. When used as a deckhead sheathing over a fibrous type of sound-absorbing or insulating material, a close-mesh, flameproof muslin should be interposed between the fibrous material and the perforated asbestos-cement sheet (flexible), to prevent particles of the fibrous material from filtering through. The flameproof muslin may be attached either to the insulant-absorbent or to the upper face of the perforated asbestos-cement sheet (flexible). This flameproof muslin is not required for the individual composite panels (acoustical units) where the

more compact sound-insulant is secured by metal grommets to a facing or perforated asbestos-cement sheet (flexible) in such a manner as to insure against movement of the sound-insulant. However, in this combination acoustical unit (panel), the insulant must not extend beyond one-fourth inch of the edge of the perforated asbestos-cement sheet (flexible) facing, unless the joint is metal-flashed.

c. *Flashing.* Asbestos-cement panel (rigid), asbestos-cement sheet (flexible), asbestos-insulating panel, and combinations with aluminum facing, will require only gnawing-edge protection. The flashing material should overlap the gnawing edge by at least one-half inch. Composition materials faced with metal will require no further ratproofing. Quarter-round, cove, or other suitable solid molding may be used for internal angles, and solid molding for external angles, in lieu of the metal flashing, except at decks. The molding should be at least three-fourths inch finished size.

If wood is used, all gnawing edges, other than the base, should be protected with metal or molding, as indicated above. The base should be protected with a standard 4-inch baseboard.

Metal backing of boundaries (except deck) and gnawing edges is satisfactory, provided that the metal backing overlaps the gnawing edge by at least 1 inch.

Plain butt joints in the surface of deckheads, double bulkheads, or sheathing over insulation, can be covered satisfactorily with wooden sealing strips or wooden molding, except that the joints behind furniture or fixtures should be flashed with sheet metal.

d. *Miscellaneous.* For miscellaneous sheet-metal work in these spaces, use 22-gauge sheet metal, 18-gauge expanded metal, 18- to 20-gauge flattened expanded metal, or 16-gauge wire mesh.

References:

Vent Screens	Item 40, p. 60.
Insulation	Item 41, p. 62.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Insulated Sleeve	Item 48, p. 64.
Service Installations	Items 36, 37, 38, 39, pp. 56–69.
Furniture and Fixtures	Item 62, p. 69.
Window Casings	Item 19, p. 41.
Doors	Item 18, p. 41.
Flooring	Item 15, p. 40.
Wardrobes	Item 63, p. 69.
Lighting Troughs	Item 21, p. 42.
Drinking Fountains	Item 65, p. 70.

30. ENGINE AND BOILER CASINGS AND MACHINERY SPACES.

a. *Sheathing.* **Metal sheathing:** 22 gauge. **Composition boards:** The use of composition boards will be considered on the merits of construction and protection provided.

Perforated asbestos-cement sheet (flexible) will not be accepted in engine and boiler casings, unless backed completely with ratproof material. It will be acceptable in the deckhead of machinery spaces without protection. Light, perforated sheet metal behind the asbestos-cement sheet (flexible) will be acceptable in all cases.

b. *Workshop bulkheads.* Single-boundary bulkheads and subdivisional bulkheads in the machinery workshops in the engine room need not be ratproofed nor specially constructed to prevent the easy passage of rats.

c. *Miscellaneous.* For miscellaneous sheet-metal work in these spaces, use 22-gauge sheet metal, 18-gauge expanded metal, 18- to 20-gauge flattened expanded metal, or 16-gauge wire mesh.

References:

Service Installations	Items 36, 37, 38, 39, pp. 56–59.
Vent Screens	Item 40, p. 60.
Insulation	Items 41, 46, pp. 62, 64.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Shaft-Alley Ceilings	Item 14, p. 40.
Skylights	Item 22, p. 42.
Machinery	Items 51, 52, p. 67.
Shelves and Bins	Items 56, 57, pp. 67–68.
Spare-Parts Boxes	Item 59, p. 68.
Lockers and Boxes	Items 60, 61, p. 68.
Furniture and Fixtures	Item 62, p. 69.
Drinking Fountains	Item 65, p. 70.
Insulated Sleeve	Item 48, p. 64.

31. FAN, RADIO, AND GYRO ROOM. The requirements for these spaces are similar to those outlined for public spaces (item 29, page 50), with one exception: Perforated asbestos-cement sheet (flexible) will be acceptable for deckhead and bulkhead sheathing, provided that the material is terminated 3 feet above the deck; if extended to the deck, the lower 3 feet should be backed with a ratproofing material, unless this portion of the space is protected by furniture and fixtures.

References:

Service Installations	Items 36, 37, 38, 39, pp. 56–59.
Vent Screens	Item 40, p. 60.
Insulation	Item 41, p. 62.
Insulated Pipes and Ducts	Items 49, 50, pp. 64–66.
Insulated Sleeves	Item 48, p. 64.
Deck Gratings	Item 16, p. 41.

SERVICE FACILITIES—PROTECTION FROM DAMAGE

32. GENERAL. Structures and installations should, whenever practicable, be protected with open, slot-type barriers, rather than with box or

enclosed types. The box type, particularly when made of wood, is a potential rat harborage, and should not be used unless its purpose is to retain insulation.

33. BATTENS. Steel flat bar, half-round bar, channel, or angle battens are preferred, but wooden battens are acceptable. Battens should be so installed as to form no troughs or partially hidden pockets over structural members, cables, or wireway casings. (See fig. 22, below.) Steel or wooden battens should be at least 2 inches apart, and at least 2 inches from any adjoining pipe or bulkhead. Space between them should be sufficient to ensure visibility, but never less than the width of the batten, except in the case of vertical pipe battens.

Vertical battens should not be on horizontal bearers wider than 1⅛ inches, and there should be a space of at least 2 inches between the bearer and the surface being protected. Battens should have a minimum clearance of 6 inches from the deck, except that the cargo face may extend to the deck. Vertical, channel-iron pipeguards and closely adjoining angle-iron pipeguards which extend to within 6 inches of a deck or tank top should have half-moon inspection holes at the bottom of the guard.

Horizontal battens should be fastened to vertical bearers or clips which are at least 1⅛ inches deep, and should have a minimum clearance of 6 inches above the deck or tank-top which they parallel.

34. PLATE GUARDS. Wide plate guards are generally undesirable, because they exclude light, interfere with inspection, hide rat runways, and create rat harborage. When installed, they should be carefully located, and should be provided with sufficient lightening holes to overcome these objections.

Semicircular, channel, and angle-type guards, when in a horizontal position, should be toed down and so placed as to hide no surface which might serve as a rat runway. Channels and angles in a horizontal position should not be toed in, unless the ledge created by the lower flange is readily visible.

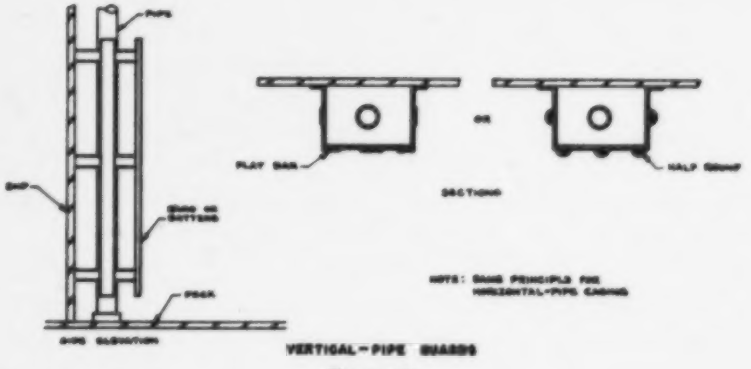
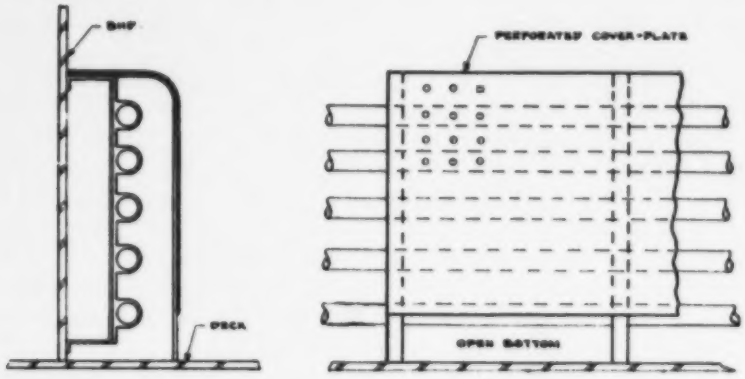


Figure 22.

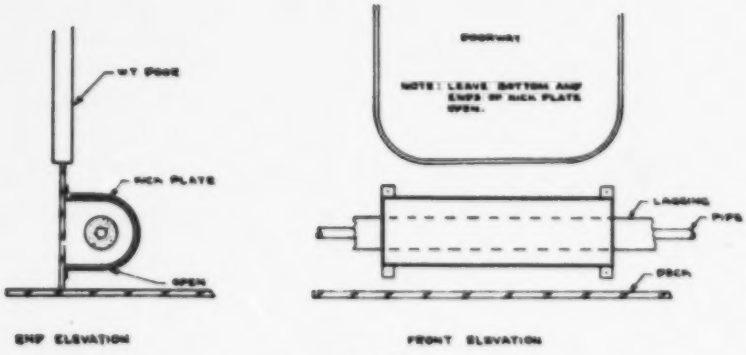
Channels should not be used where they hide the upper surface of, or space between, horizontal pipes, cables, and similar appurtenances.

Protective covers for heating pipes or coils, and for kickplates in way of doors, should not extend to the deck, nor horizontally beneath the pipe or coil. It is preferable that protective covers for pipe terminate at least 6 inches above the deck, and that they be open at both ends. If complete enclosure is necessary, there should be no holes in the casing larger than one-half inch.



PROTECTIVE COVER FOR HEATING PIPE OR COILS

Figure 23.



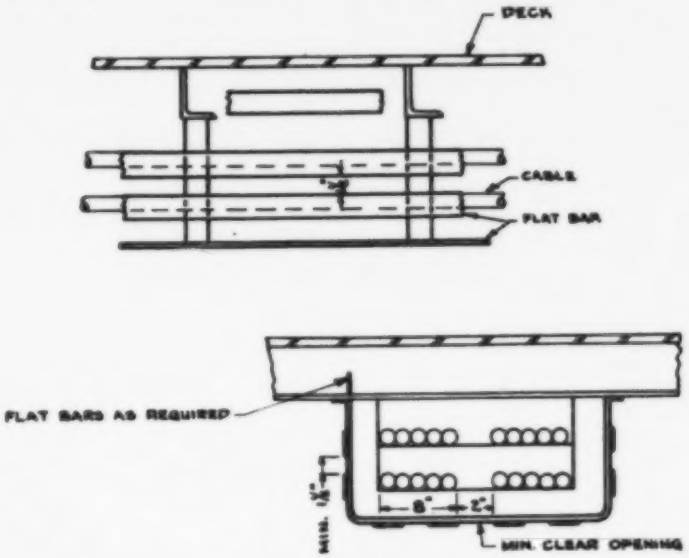
KICK PLATE

Figure 24.

35. WIREWAY AND CABLE GUARDS. Wireway and cable guards of the metal-bar type are preferable, from a ratproofing standpoint. They should be installed wherever the location of the cable or wireway is such as

to create no rat harborage and does not prevent the inspection of the top of the wireway. In places where harborage is created, the cable or wireway should be enclosed in a ratproof casing.

Bar-type guards should be constructed of bars not over 2 inches in width, which are so placed as to have a clearance between bars of 2 to 4 inches. In no case should the clearance between bars at the side be less than 1½ inches. The cables should be so placed that the top of each layer is opposite the top of a bar. The cables should be in groups, preferably not more than 8 inches wide, with an opening of at least 2 inches between groups. The slots thus created should be above each other where there are several layers of cables, and the bars which form the underside of the wireway guard should not be below these slots.



BAR-TYPE CABLE GUARDS

Figure 25.

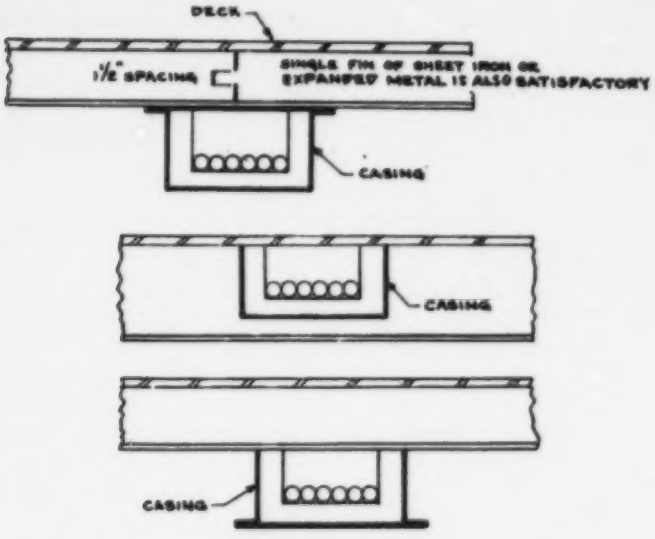
Casing-type wireway or cable guards should be of adequate strength, and of material suitable to the space in which installed. Metal casings are preferred, but nonratproof materials are suitable, in passageways and similar spaces.

Wireway casings should consist of portable sections. The weight and size of each section, and the method of attachment, should be such as to facilitate removal and replacement.

Casings should extend continuously through ratproof boundaries or double bulkheads; otherwise, the openings in these bulkheads, through which the cables pass, should be ratproofed.

Cable and wireway casings and junction boxes should be placed at least 6 inches above the deck or finished flooring, or the space should be ratproofed.

At the deckhead, wireway casings which are parallel to the beams should be placed as recommended for ventilating and heating ducts in item 39, page 59. Those casings which are below, and run transversely to, the deckhead beams should terminate at the lower surface of the deckhead beams, and should not extend into the space between beams.



ENCLOSED CASINGS

Figure 26.

Cables should enter casings through nipples or stuffing tubes. Sheet-metal collars should be installed at such penetrations of expanded metal if there are openings greater than one-half inch.

SERVICE FACILITIES—INSTALLATIONS

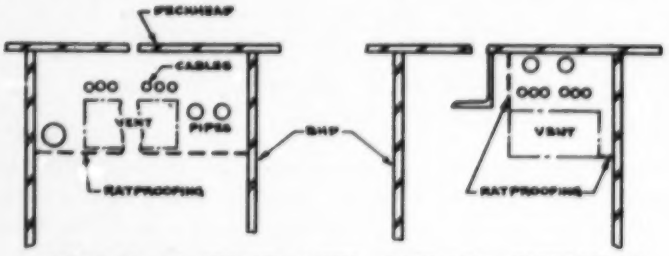
36. GENERAL. Service lines should be installed, if possible, in such a manner as to avoid creating rat harborages and spaces which cannot be inspected and cleaned. It is realized that this ideal arrangement is not always possible, but nevertheless, should be striven for.

Most service-line installations should be left open. Where uninspectable areas are created, the need for ratproofing will have to be determined, with due consideration for such factors as the amount of light above the

service lines, whether or not some space exists between them, and whether or not any of the lines or adjacent fixtures are insulated.

Where no insulating material is involved, and when the space above the service lines is well-lighted, no ratproofing will be required, even though the upper surfaces may be uninspectable.

When ratproofing is necessary, service lines should be completely encased. When enclosures are necessary in passageways, the facilities should be placed high enough to permit the installation of portable inspection panels.



GROUPING OF SERVICE LINES REQUIRING RATPROOFING

Figure 27.

All penetrations (by pipes, cables, wireway, and ducts) of bulkheads, decks, deckheads, and partitions which form the boundaries of ratproof spaces, should be ratproof. Penetration of other surfaces should be closed, to prevent rats from using the service lines as runways. In closing spaces around penetrating service lines, thought should be given to the possibility of the lines shifting to one side of the hole, making the aperture larger than would be the case if the line remained centered.

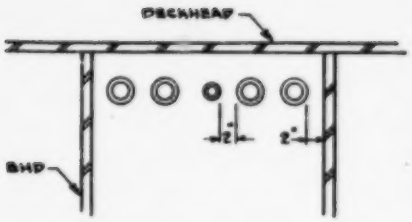
37. PIPES. All exposed pipes, except in propelling- and refrigerating-machinery spaces, should be installed away from corners, stiffeners, bulkheads, bosoms of beams, brackets, and similar fixtures. They should be kept sufficiently spaced (with respect to one another) to permit easy inspection. At least 2 inches should occur between pipes, and between a pipe and any surface that parallels it. (See fig. 28, p. 58.)

When it is necessary to place pipes in contact with one another in horizontal layers, the grouping should be limited to about 8 inches in width, with 2 inches between groups. When these provisions are impracticable, and uninspectable surfaces and rat harborages are created, enclosure may be essential.

Horizontal pipes should be kept at least 6 inches from the deck or tank-top, and a sufficient distance from bulkheads, sheathing, and structures on deck.

References:

Pipe Insulation ..... Item 49, p. 64.
Penetrations of Expanded Metal, or Wood, or Other Nonratproof Bulkheads ..... Item 5c, p. 37.



KEEP PIPE LAGGING AT LEAST 2" AWAY FROM PARALLEL BHD AND MAINTAIN MAX SPACING BETWEEN PIPES

DESIRABLE GROUPING OF PIPE

Figure 28.

38. CABLES—ELECTRIC, TELEGRAPHIC, AND DEGAUSSING. Cables in groups should be attached directly to bulkheads or deckheads, or within one-half inch of them, wherever practicable. The grouping should be limited to about 8 inches in width, and there should be a space of at least 2 inches between groups. When cables are installed and not encased, the backing plates to which the cables are attached should be not less than 8 inches wide, with a 2-inch space between paralleling plates.

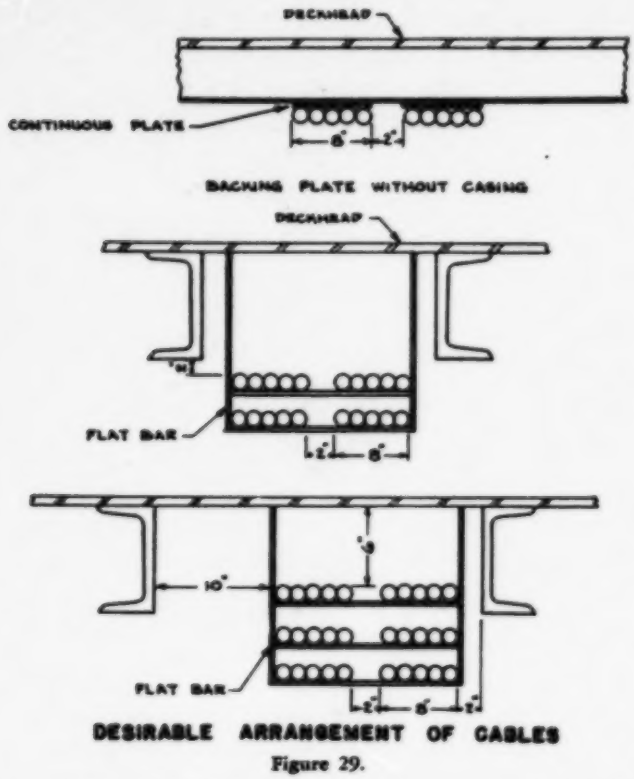
When an open, inspectable type of cable installation is impossible and rat harborage is created, the cables should be enclosed.

Cables should pass through stuffing tubes, thimbles, or nipples, wherever they penerate bulkheads, deckheads, and partitions, or enter closed wireway guards and pull-, fuse-, or switch-boxes. Direct penetrations of metal surfaces by individual cables should be ratproofed.

When sheet-iron collars are installed, they should fit to within one-fourth inch of the outer surface of the individual cable or group of cables. When placed around a wireway, the inner edge of the collar should be cut to conform to the outer surface of the wireway. A strip of sheet lead can be placed around the cable or wireway, as a safeguard against the insulation being cut by the collar. Placing the two halves of the collar tightly against the cables will prevent vibration and cutting.

Lead, portland-cement mortar, putty, and certain plastic sealing compounds are not suitable for ratproofing openings around cables. Special cements and plastics, which become hard and are resistant to abrasion and cracking, may be satisfactory for closing openings around wireways within ferrules at bulkheads. However, this type of material should not be used for ratproofing where it is possible to install sheet-metal collars.

A heavy flange on a stuffing box, a washer behind a nut, or the nut of a nipple, if covering the gnawing edge of a penetration of hard composition material at least one-fourth inch, will provide satisfactory protection in lieu of a sheet-metal collar.



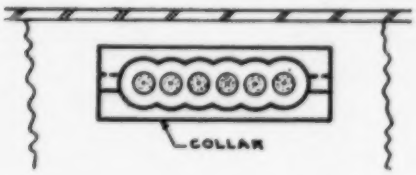
DESIRABLE ARRANGEMENT OF CABLES

Figure 29.

39. VENTILATING, AIR-COOLING, AIR-CONDITIONING, AND HEATING SYSTEMS. Mushroom and torpedo ventilators in the superstructure should be continuous when passing through double bulkheads or deckheads. Where necessary, the sleeve of the ventilator should be extended by the addition of sheet metal. Penetrations of nonratproof bulkheads, deckheads, or sheathing should be collared. (See item 5c, p. 37.)

Air ducts should be so constructed and located that rat harborages will not be created. They should be continuous when passing through double bulkheads and insulation. Nonratproof materials are suitable for certain spaces other than general-cargo holds, provided that all gnawing edges are flashed. Air ducts which traverse the void space within double bulkheads or deckheads should be ratproof.

Rectangular air ducts should be installed either tightly against, or entirely away from, deckheads and bulkheads, to permit inspection. If not flush with the deckhead plate, the duct should be sufficiently below the deckhead beams to permit inspection of the top, but in no case less than 2 inches when the casing runs parallel with the deck supports. In passageways and



SHEET-METAL COLLAR FITTED WITHIN 1/4" OF CABLE. LEAD FERRULE MAY BE APPLIED

COLLAR AROUND INDIVIDUAL CABLE

CABLE COLLARS

Figure 30.

similar spaces, it may be necessary to place the ducts between beams, but not flush with the deckhead. With this arrangement, the space on the side should be at least 10 inches wide, and the space above the casing at least 3 to 4 inches, in order to permit inspection.

The cutting of lightening holes in adjoining structural members, to facilitate inspection, should be avoided unless good visibility will be obtained thereby. Lightening holes never should be installed where they will adversely affect the strength of a structural member.

Spaces made uninspectable by the arrangement of ventilating or heating ducts should be completely enclosed with sheet iron, except as may be indicated in item 36, page 56. Expanded metal or wire cloth is suitable, in lieu of sheet iron, except in cargo spaces.

In this connection, refer also to:

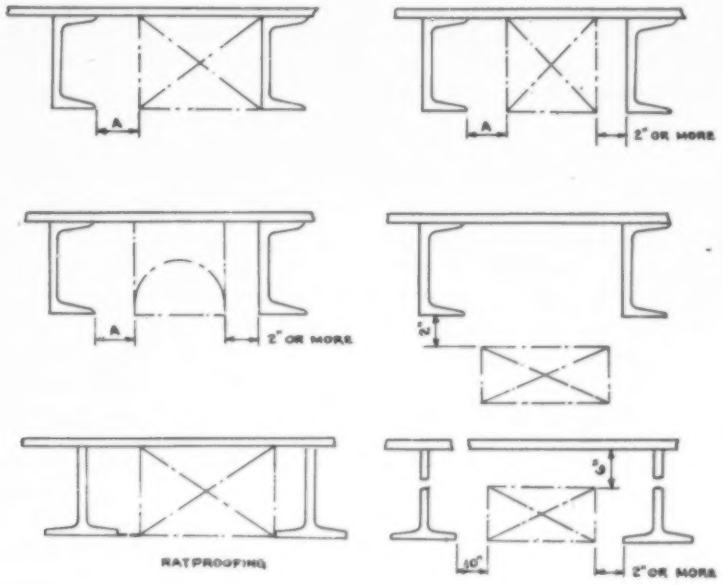
Penetration of Nonratproof Bulkheads, item 5c, page 37.

Refrigerated-Cargo-Space Ducts, item 25, page 43.

Ratproofing of Insulation on Ducts, item 50, page 66.

40. SCREENING OF VENT OPENINGS. Intakes, exhausts, and outlets should be protected by ratproof screening, unless the opening is equipped with a louver in which no slot or hole is greater than one-half inch. Insect screening is not satisfactory as ratproofing.

All gravity and forced-draft intake and exhaust openings should be ratproofed. An individual gravity ventilator or forced-draft duct which passes directly into one compartment needs to be ratproofed on the intake end; the outlet end need not be ratproofed, unless a rat harborage is created by a horizontal extension of the duct. Ducts extending from the weather deck directly to the cargo holds, engine room, and boiler rooms, with no horizontal extensions, need not be ratproofed at either end. The service outlet of a cold-air or hot-air system which serves more than one compartment should be ratproofed. Ventilation-louver openings in living quarters, dining rooms, and other public spaces need not be ratproofed, provided that they are located in the deckhead near the center of the space, and that there are no avenues of approach and little likelihood of one being provided.



NOTE: DIMENSION "A" SHOULD BE SUCH AS TO PERMIT VISUAL INSPECTION OF THE ENCLOSED SPACE

VENTILATION DUCTS

Figure 31.

The perforations in, or mesh of, the ratproofing material should be no greater than one-half inch, and the gauge should be no less than that given in table III, page 62.

TABLE III.—*Gauges of ratproofing materials for protecting air intakes, exhausts, and outlets*

Service	Perforated sheet iron	Expanded metal		Wire cloth	Sheet-iron frame [1]
		Raised	Flattened		
Intakes and exhausts	16	16	16-18	14	18
When exposed to weather	14	13	13-15	13	16
Outlets:					
General-cargo holds	16	16	16-18	14	18
Refrigerated-cargo holds	16	16	16-18	14	18
Into other spaces	18	18	18-20	16	22
Intakes, exhausts, and outlets: Through large, unprotected (structurally) grills	14	13	13-15	13	18

[1] When doubled and crimped over the edge of the screening material, the next-lighter even-numbered gauge may be suitable, but none lighter than 22-gauge should be used.

Ventilating hoods and canopies should terminate flush with the deckhead, or should slope toward the open deckspace. They should be screened as specified above. Pipes, cables, air ducts, and similar features over tops of hoods should not be so grouped as to form spaces or pockets which will be inaccessible for inspection; any spaces so formed should be completely closed with sheet iron of 18- or 22-gauge, according to the need.

INSULATION

41. GENERAL. Rats have been observed to burrow through, and harbor, and raise young in insulation commonly used on vessels. Insulation of 1 inch or less in thickness, which is placed in contact with the surface being insulated, and which is not sheathed, need not be ratproofed. For insulation which is sheathed, ratproofing will be required when the insulation is over three-fourths inch thick.

All insulation thicker than 1 inch should be ratproofed, unless the insulation is within a ratproof void space. A combination of a void and an insulation thickness greater than 1 inch should be ratproofed.

Insulation or its sheathing should be completely covered with ratproof material, but flashing of the sheathing will be satisfactory, if done in accordance with the recommendations in item 5b, page 36.

Expanded metal (½-inch mesh) will be satisfactory as sheathing of insulation in spaces other than galleys and pantries. The expanded metal should extend to within one-fourth inch of structural plates, or should join other ratproofing material. When the expanded metal is to be covered with a plaster coat, the plaster should not be applied until the expanded metal has been inspected. (See fig. 32, p. 63.)

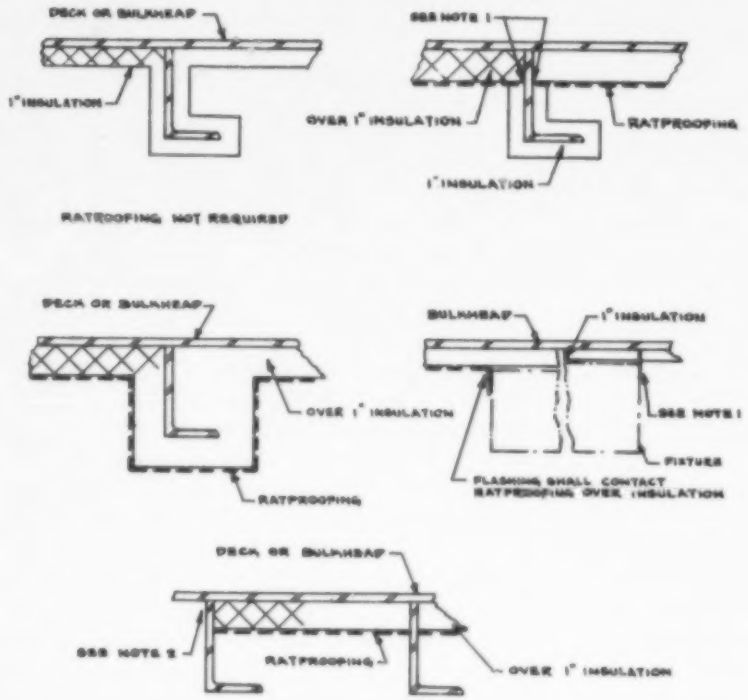
When metal or wooden furniture is placed flush against 1-inch-thick insulation, a strip of 22-gauge sheet metal should be placed entirely around the furniture, and should extend through the insulation to within one-fourth inch of the metal behind the insulation. (See fig. 32, note 1, p. 63.)

42. DECK. Deck insulation of cork or other material thicker than three-fourths inch, in spaces other than public spaces, should be so sheathed

as to prevent the entrance of rats into the insulation. When the substantiality of the flooring does not obviate the need of ratproofing, the insulation should be completely covered with ½-inch-mesh material (18-gauge expanded metal, 18- to 20-gauge flattened expanded metal, or 16-gauge steel-wire cloth in refrigerated spaces, and the next-lighter even-numbered gauge in public places. When mesh material is essential, it may be placed just above the insulation, or within or between layers of the covering material.

For information on the ratproofing of deck insulation in refrigeration spaces, see item 25e, page 45.

43. GENERAL-CARGO HOLDS. Insulation in general-cargo spaces should have the ratproofing material placed directly on the insulation. When special protection of the ratproofing material is provided, the insulation can be covered satisfactorily with at least 16-gauge sheet iron; otherwise, a heavier-gauge material is recommended.



RATPROOFING OF UNSHEATHED INSULATION

Figure 32.

44. REFRIGERATED-CARGO SPACES. Insulation on exposed surfaces within refrigerated-cargo spaces should be ratproofed by complete coverage with sheet iron or flashed sheathing.

45. REFRIGERATING-MACHINERY SPACE. Insulation on machinery, pipe, pipe manifolds, valve cabinets, and similar appurtenances within refrigerating-machinery spaces are exempted from ratproofing, provided that the boundary bulkheads and deckhead, the sheathing over voids or insulation therein, and the penetrations of bulkheads and the deckhead are ratproofed, and the door is conspicuously labeled KEEP CLOSED.

46. ENGINE AND MACHINERY CASING. Insulation on machinery, pipe, pipe manifolds, valve cabinets, and similar appurtenances within engine and machinery casings need not be ratproofed, provided that the boundary bulkheads and deckhead, the sheathing over voids or insulation therein, and the penetrations of bulkheads and the deckhead are ratproofed.

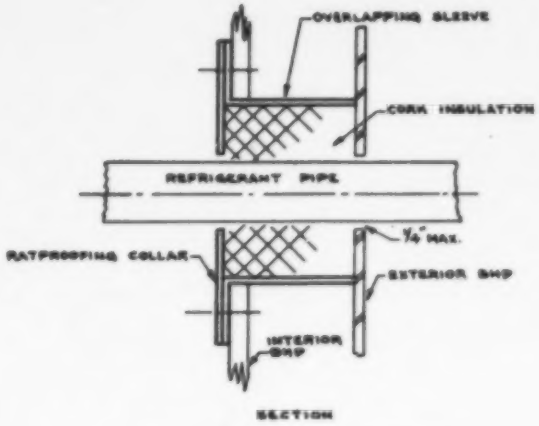
47. GALLEY AND PANTRY. Insulation on the gallery and pantry deckheads and bulkheads should be sheathed with metal or some other hard, smooth-surfaced material.

Cloth-covered, fibrous insulation, and plaster-covered expanded metal or metal lath, are not satisfactory in galleys and pantries, nor are sealing compounds used for closing openings around fixtures which penetrate deckhead insulation. This is because of the danger of fibrous material falling into food through breaks in the material.

48. SLEEVES. Sleeves should be installed around insulated pipes which pass through double bulkheads and deckheads of refrigerated spaces. Service lines to refrigerated spaces should pass through the double bulkhead or deckhead within stuffing tubes; otherwise the service lines should be protected against the entrance of rats into the insulation around the pipe or the insulation within the double deckhead or bulkhead. The cork or other insulation around that part of a pipe or tube which is within a deckhead or between double bulkheads should be enclosed in a sleeve of at least 22-gauge sheet iron, or its equivalent. The sleeve should extend the full length of the pipe insulation, and should terminate at the outer surface of the bulkhead or deckhead in which the hole has been cut for the insertion of the pipe insulation.

In addition to the sleeve, sheet-iron collars (as described in item 5c, p. 37) should be placed around the penetrating pipe at the outer surface of bulkheads which are of nonratproof material. When the bulkhead which is penetrated by the pipe insulation is of metal, a suitable, removable collar should be applied. When the external bulkhead which is penetrated by the refrigerant pipe or tube is of metal, the annular space in the bulkhead around the pipe or tube should be no wider than one-fourth of an inch.

49. PIPES. Pipe and pipe fittings which carry brine or other refrigerants, and which are covered with hairfelt or similar insulation of 2 inches or less in thickness, need not be ratproofed. For insulation which is thicker than



SLEEVE AROUND INSULATION WITHIN DOUBLE BULKHEADS

Figure 33.

2 inches, the need for ratproofing will be judged on the basis of arrangement and location.

Other pipes insulated with hairfelt or similar material thicker than 1 inch should be ratproofed.

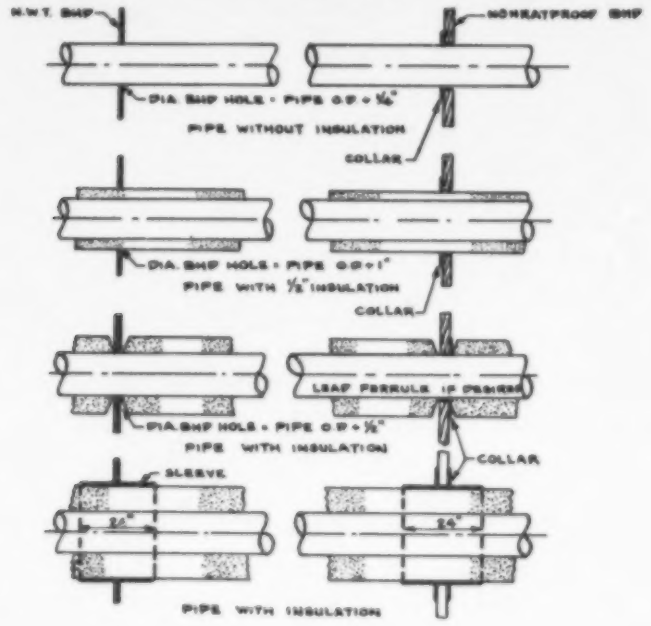
The need for ratproofing cork insulation (regardless of thickness) around pipes, including those carrying refrigerants, will be judged on the basis of arrangement and location.

All insulated pipes should be wrapped separately, and should be so spaced as to allow at least 2 inches between wrappings, if practicable. Where two or more pipes are insulated and wrapped together, or insulated separately and enclosed in one wrapper, the need for ratproofing should be judged on the basis of arrangement and location.

When ratproofing is necessary, it should consist of sheathing the pipe or pipes with at least 24-gauge sheet iron or 18- to 20-gauge, ½-inch-mesh hardware cloth. The wire cloth should be applied beneath the wrapping, and may be embedded in the insulation not more than 1 inch from its outer surface. All penetrations of nonratprof material by insulated pipe should be collared in accordance with item 5c, page 37, and such penetrations should comply with the following special recommendations:

Insulation which is not thicker than one-half inch may extend, without break, through bulkheads. Bulkheads of ratproof material, and the collars at bulkheads of nonratproof material, may terminate at the surface of the insulation. When the insulation is thicker than one-half inch, bulkheads of ratproof material and the collars at bulkheads of nonratproof material should extend to within one-fourth inch of the pipe surface. When the partition is of wood, a sheet-iron collar should be applied. Where the insu-

lation is thicker than one-half inch and it is necessary to run the insulation without break through a bulkhead, a 24-inch, 22-gauge, sheet-iron sleeve should be fitted over the insulation, centered at the bulkhead.



PIPE PENETRATION OF BULKHEADS
Figure 34.

50. VENTILATING, AIR-CONDITIONING, AND HEATING DUCTS. Hairfelt or similar insulation which is less than 1 inch thick, over ventilating, air-conditioning, and heating ducts, need not be ratproofed. For insulation over 1 inch thick, ratproofing will be necessary. When cork is used, the need for ratproofing will be judged on the basis of arrangement and location.

No ratproofing will be necessary in the case of vent ducts which are located within double bulkheads or deckheads which are ratproof, or in fanrooms which have ratproof boundaries and whose doors are marked KEEP CLOSED. Ratproofing, if necessary, should consist of complete coverage with 24-gauge sheet metal, ½-inch mesh, 18- to 20-gauge steel-wire or hardware cloth, 20-gauge expanded metal, 20- to 22-gauge flattened expanded metal, or 3.4-pounds-per-square-yard galvanized or painted metal lath with an acceptable hard-plaster coating. The ratproofing material should be placed over the insulation and beneath any covering.

In cargo spaces, the ratproofing material should be at least the next-heavier even-numbered gauge.

MACHINERY AND DECK EQUIPMENT

51. GENERAL. Ratproofing of machinery and deck equipment will be required only when a serious harborage is created.

52. MOTORS. Motors which are not regularly used, and which are located in unfrequented places, should be ratproofed with 18-gauge or heavier hardware cloth, when there are access openings into the motor windings.

53. WEATHER-DECK MACHINERY AND EQUIPMENT. Machinery and equipment (and the foundations thereof) which are located on the weather deck should be so constructed or ratproofed as to provide no temporary hiding place or permanent harborage for a rat. It is preferable that open-type construction should be employed. All spaces to which a rat might gain entrance should be sufficiently open to admit light and to facilitate inspection and cleaning. Where open construction is impracticable, the space should be closed, with no holes greater than one-half inch. Closures should be effected with at least 16-gauge sheet metal, ½-inch-mesh 13-gauge expanded metal, or 13- to 15-gauge flattened expanded metal.

When the space within the foundation or beneath a solid base or cover plate can be viewed from opposite sides, the height of the space should be sufficient to permit easy inspection. When it is less than 6 inches, creating a rat harborage, the space should be closed.

54. ROPE AND CABLE REELS. Rope and cable reels should be of metal construction, and should be installed on open-type metal supports. The center core should be of solid or perforated metal. Hollow axles having a diameter greater than 1 inch should be plugged, unless the area is inspectable.

55. MOORING FITTINGS. Bitts, chocks, cleats, and other mooring fittings should be either open for inspection or completely closed. Any rat harborage within or adjoining such fittings should be ratproofed with heavy ratproofing material. Holes in castings greater than one-half inch, such as are sometimes found in cross-shaped mooring bitts, should be sealed with metal or plugged with wood.

STOWAGE-SPACE FACILITIES

56. SHELVES. Shelves or platforms should be so installed as to avoid the creation of pockets or hidden places. When such places are unavoidable, they should be enclosed with sheet iron of at least 22-gauge. Shelves and platforms used for the storage of foods should be constructed of bars, slotted or perforated metal, or expanded metal. When shelves are made of solid plate, the railings at the edge should be raised one-half inch or more above the surface of the shelf, to permit cleaning.

The lowest shelf of a tier or raised platform should be high enough to facilitate inspection and cleaning. Where a tier of shelves is installed, the back of which is covered with mesh material, the arrangement should be

such that debris which passes through the wire will fall to the deck where it can be removed. There should be access to the bulkhead behind the shelves for cleaning and painting.

57. BINS. Bins should be placed either flush against, or well away from, bulkheads and structural members; if not flush with the deck, the space underneath should be ratproofed, as set forth in item 62, page 69. All bins should have tight-fitting covers, preferably of the self-closing type.

58. CARBON-DIOXIDE CONTAINERS. Containers of carbon dioxide and other gases, when grouped together, should be installed in a ratproof space or enclosed within one-half-inch wire-mesh bulkheads.

59. SPARE-PARTS BOXES. Large spare parts, such as propellers, propeller blades, and shaft sleeves, should be stowed in a ratproof manner. From a ratproofing standpoint, they should not be encased. When this is not possible, and when the casing is of nonratproof material, ratproofing will be necessary, unless the parts are stowed in a ratproof compartment.

Small spare-parts boxes should be ratproofed, unless they are to be stowed in a ratproof compartment. The space could be used jointly for the stowage of boiler tube, pipe, and firebrick.

60. LOCKERS. All lockers and boxes preferably should be of metal, but they may be of wood or other nonratproof material, provided that they are properly lined or flashed. All exposed, cut edges of wire cloth or expanded metal should be bound or flashed with at least 22-gauge sheet iron. Wooden lockers or boxes should be flashed in accordance with the flashing requirements for the spaces in which they are located.

Lockers and boxes should be installed in such a manner as to form no rat harborages at the deck or deckhead, or with adjacent structures. If not placed flush with the deck, the locker or box, when subject to rat damage, should be elevated at least 6 inches, or the space should be closed with sheet iron of at least 22 gauge.

Lockers which approach the deckhead should be so installed that an enclosed space will not be created at the top of the locker.

Lockers of wood or metal, located in living quarters or in otherwise ratproof compartments (paint room, etc.), need not be ratproofed. It will be necessary to ratproof the boundaries of a locker in way of a void space created by a fixed false bottom (except when the covering over the void is portable), regardless of the locker location.

Built-in lockers should be so constructed as to create no openings into double bulkheads or deckheads. In living quarters, only the sides and top of the locker which are part of the double bulkhead or deckhead need be ratproofed.

61. BOXES. Weather-deck boxes of solid wood should be ratproofed over the entire bottom and the lowest 1½ inches of the sides. If constructed of tongue-and-groove or shiplap, the lower edges need to be flashed 1½ inches on each side of the gnawing edge with at least 22-gauge sheet metal. Slotted, wooden deck boxes should be completely lined, except that

the top, if of solid construction, need not be covered. Twenty-two-gauge sheet metal or 18-gauge wire mesh will be satisfactory, if placed on the inside, with material of the next-heavier even-numbered gauge being used when exposed to the weather.

Storeroom boxes, either solid or slotted, should be completely lined, including the top. Solid wooden boxes constructed of tongue-and-groove or shiplap should have the edges flashed 1½ inches on each side of the gnawing edge with at least 22-gauge sheet metal. Ratproofing of boxes will not be required if they are stored in a ratproofed space.

FURNITURE AND FIXTURES

62. GENERAL. Furniture, preferably, should be made of metal. Ratproofing will not be required of wooden furniture which has no openings greater than one-half inch, and which affords complete visibility of the interior of the base by such means as the removal of drawers or loose false bottoms. Finger holes should not be larger than one-half inch. Wherever the interior of the base is not visible because of a complete or partial fixed bottom, or because a drawer cannot be removed, the gnawing edges should be protected. Furniture located in public spaces need not be ratproofed if there are no openings greater than one-half inch leading to void spaces.

Whenever possible, furniture and fixtures should be installed flush with the deck or elevated at least 6 inches. Partially enclosed spaces around furniture which cannot be swept with a broom or reached at arm's-length for cleaning should be closed with 22-gauge or heavier sheet iron.

Gnawing edges of all types of bulkheads behind furniture should be flashed in the same manner as other parts of the space in which the furniture is located. In addition, plain butt joints between boards or wall panels of nonratproof material should be flashed.

63. WARDROBES. Wardrobes, preferably, should be made of metal. Wooden wardrobes should be ratproofed as recommended in item 62, above, except when they are located in living quarters and public spaces. A side of the wardrobe which is part of a double partition should be ratproofed. Shoe racks located at the base of wardrobes should meet the requirements of item 62.

64. GALLEY FIXTURES. Fixtures in galleys should be so designed and located as to afford neither harborage for rats nor places for the accumulation of food. All galley fixtures should be of metal, and all seams therein should be fitted closely and, preferably, soldered. All snipe, construction, or other holes leading into metal fixtures should be closed. Galley fixtures should be elevated on legs.

The galley range should have a ratproof foundation. When the perimeter of the foundation and the bottom of the range do not effectively close the space, it should be covered with 18-gauge or heavier sheet iron, or filled with lightweight concrete. Any space between the range and the bulkhead

which is inaccessible for cleaning should be enclosed with at least 18-gauge sheet iron. The hood over the galley range should be ratproofed if necessary, as recommended in item 39, page 59.

The bottom of other galley fixtures, and the lowest shelf of a tier, should be ratproofed as recommended in item 62, page 69.

The splash plates at the back of the sinks and dressers should extend to, and be attached to, the bulkhead against which they are placed. Where stiffeners interfere, suitable sheet metal should be used to extend the splash plate, on a steep, upward angle, to the bulkhead. It should be fitted closely, and welded or soldered to the bulkhead and stiffeners. A portable plate should be placed around pipes, where needed to facilitate repair.

65. ELECTRIC REFRIGERATORS, DRINKING FOUNTAINS, AND DRINKING-WATER COOLERS. The machinery compartment should be solidly enclosed, and screened with 16-gauge wire cloth or 18-gauge expanded metal, or equipped with ½-inch louvers. Where holes are cut in the mesh for the passage of waterpipes or electric cables, metal collars should be provided. Front doors of machinery compartments should be tight-fitting on all sides.

MISCELLANEOUS

66. FIRE STATIONS. Fire stations should be so constructed as to prevent rat harborage and facilitate inspection. This is important, in the interest of both rodent control and safety, because rats will nest even behind orderly piles of hose.